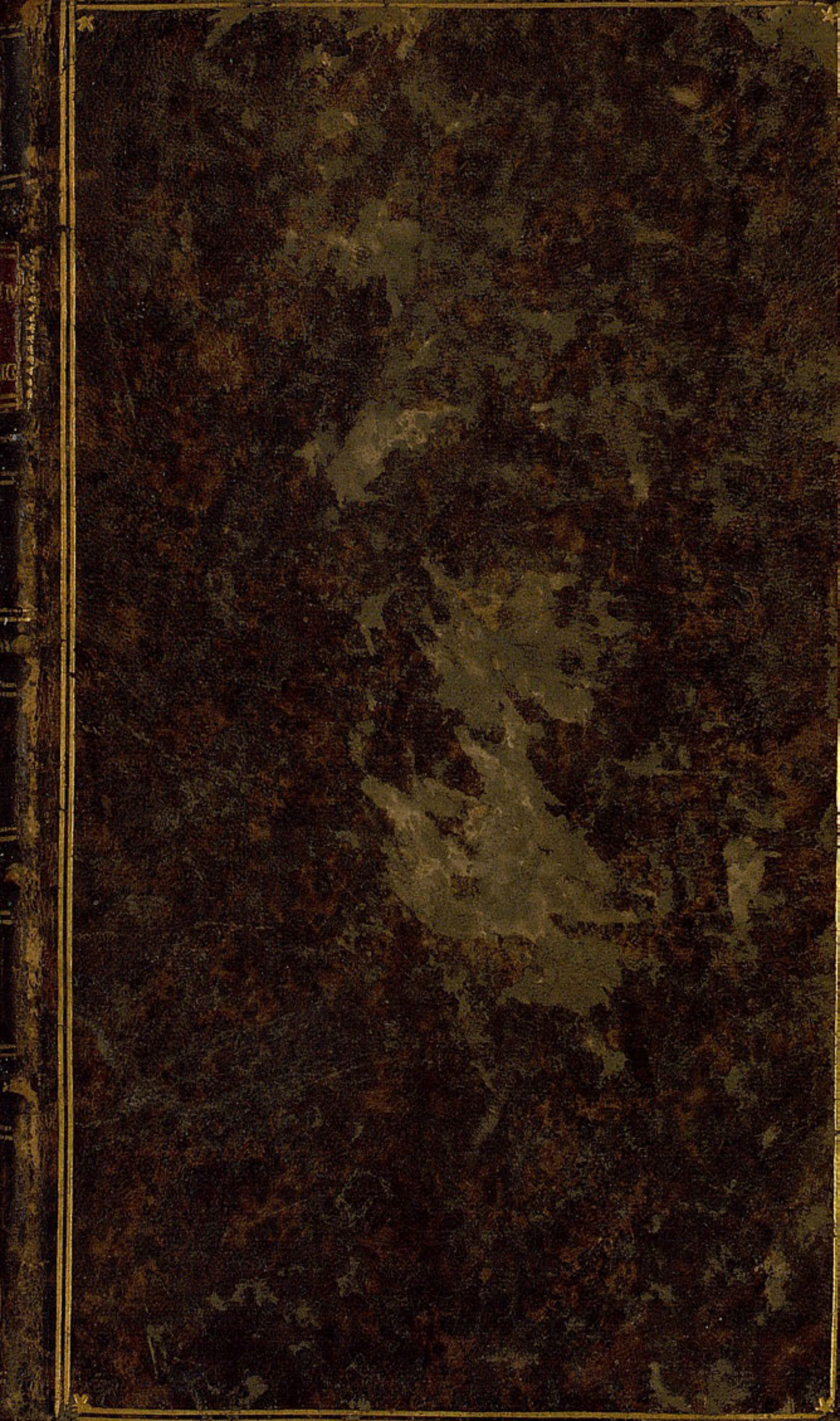
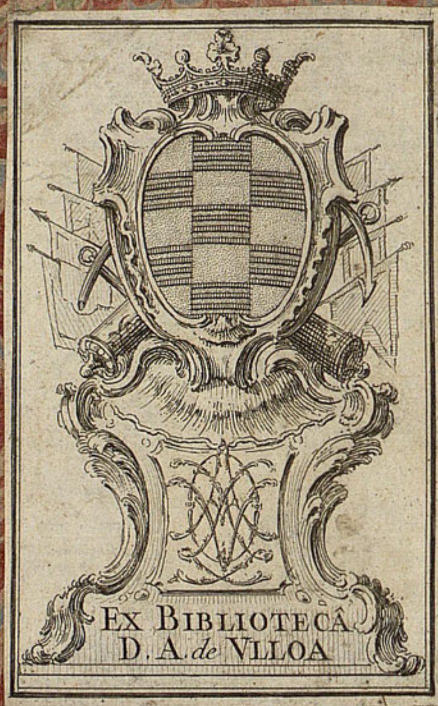

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A

DISSERTATION

CONCERNING

ELECTRICITY.

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A

DISSERTATION

CONCERNING

ELECTRICITY.

By *J. T. DESAGULIERS*, LL.D. F.R.S.
Chaplain to HIS ROYAL HIGHNESS
the PRINCE of *WALES*.

To which is Annex'd,

A Letter from Preſident *BARBOT* perpetual Secretary of the Academy of *Bordeaux*, to acquaint him that his Diſſertation had won the Prize propoſed by that Academy to be given to the Perſon who ſhould write beſt upon that Subject.

LONDON:

Printed for W. INNYS, and T. LONGMAN.

M. DCC. XLII.



N. B. EVERY Author of a Dissertation on the Subject proposed, writes some Motto or Sentence at the bottom of his Dissertation; and also sends his Name and Titles, together with the same Motto, sealed up. The Academicians first examine all the Dissertations without knowing their Authors, and when they have adjudged the Prize to any one of the Dissertations,

tions, they open the ſealed Papers to find out the Author, whoſe Name has along with it the Motto of the Paper winning the Prize.



N. B. *For the ſake of ſuch Perſons as are curious to know what* Electrical Experiments *have been made; thoſe Places in the* Philoſophical Tranſactions *of* London, *and in the* Memoires *of the Royal Academy of Sciences of* Paris, *and other Treatiſes concerning this Subject, are referred to, where the Experiments are deſcribed at large.*



A DISSERTATION CONCERNING ELECTRICITY.

ELECTRICITY is a Property of ſome Bodies, whereby they alternately attract and repel ſmall Bodies when brought near them, and that at ſenſible Diſtances, *viz.* from a quarter of an Inch to the Diſtance of two or three Foot, and ſometimes beyond.

The firſt kind of Bodies in which this Virtue or Property has been obſerved is the *Electrum* or Amber, for which Reaſon it has been called *Electricity*, which Name has been retained, tho' the ſame Virtue has been obſerved in a great number of other Bodies; as for example, in all ſorts of Glaſs, Cryſtals, and precious Stones; Reſins, Sulphurs, and

ſome Minerals; dry animal Subſtances, and Vegetables (tho' rarely) but never Water and watery Fluids, moiſt Bodies, and Metals.

The Electricity which is inherent in ſeveral Bodies is hardly perceptible, unleſs they have a vibratory Motion given to them, by Friction or any other Means, ſo as to cauſe them to throw out *Effluvia* or Emanations.

I diſtinguiſh all Bodies into ſuch as are *Electricks per ſe* (or of themſelves) *and Non-Electricks per ſe.* A Body that is *electrick per ſe*, is ſuch an one in which Electricity may be excited by ſome Action upon that Body, ſuch as rubbing, patting or warming it, and ſometimes only expoſing it to cold and dry Air after it has been covered, *&c.* A *Non-Electrick per ſe* is a Body which cannot be excited to Electricity by any Action upon the Body itſelf. But yet *Non-Electricks per ſe* receive Electricity, when you bring near them *Electricks per ſe* in which Electricity has been excited. In order to know, that Non-Electricks have received the communicated Electricity, they muſt be *inſulated*, that is, they muſt not be ſuſpended from, or ſupported by any Bodies but what are *Electricks per ſe*; for if a Non-Electrick be touched

by

by another Non-Electrick, which touches a third, and ſo on; all the Electricity received by the firſt will go to the ſecond, and from the ſecond to the third, and ſo on, till at laſt it be loſt upon the Ground, or the Earth. But if ſeveral Non-Electricks touching one another, are at laſt terminated by Electrick Bodies, in that reſpect they make but one Body, and receive and retain Electricity for ſome time.

There are ſeveral ways of finding when Non-Electricks have received Electricity; (which is generally communicated to them by applying a Glaſs-Tube, excited by Friction, to one End of thoſe Bodies) of which here follow a few. If an Iron-Bar be ſuſpended horizontally by two ſilken Strings that are very dry, and the rubb'd Tube be applied or brought near to one of the Ends of the Bar, and then ſome Leaf-Gold or Leaf-Braſs, or any other light Bodies plac'd upon a ſmall Stand be brought near the other End, they will be alternately attracted and repell'd by the Bar. Likewiſe if you bring your Face or the End of your Finger near the ſaid End of the Bar; the electrical Effluvia coming out on the ſudden will make a ſenſible Prick-

ing, with a ſnapping Noiſe, and produce a Flaſh of Light that may be ſeen in the dark. A ſmall flaxen Thread about a Foot or two long, ſuſpended by a Stick, and being brought near the Bar, will be attracted by it without deſtroying its Electricity till after ſome time. That Thread (which we ſhall call *the Thread of Tryal*) ſerves to find out when the Bar or any other non-electrick Body has receiv'd the communicated Electricity.

A Body which is *electrick per ſe*, does not receive this Virtue from another *electrick per ſe* tho' excited, till it is become a *non-electrick*; which happens when it is made moiſt; and then it will be made electrick only by Communication. So that an *electrick per ſe* may become *non-electrick*; and likewiſe a Body *non-electrick per ſe* may become electrick by Communication.

Thoſe electrick Bodies in which it is difficult to excite Electricity, may be look'd upon as *Non-Electricks*, when their Electricity is not excited: and then they will be in the ſame Condition as *Non-Electricks per ſe*, and be liable to receive Electricity by Communication in the ſame manner.

As there are a very great number of electrick Bodies, which act after the ſame manner when Electricity has been excited in them, I ſhall here mention only the Tube of Glaſs which is rubb'd by the Hand, referring my Reader for the Enumeration of other electrick Bodies, and their Effects, to the late Mr. *Hawkſbee*'s Book of Phyſico-mechanical Experiments, to the Philoſophical Tranſactions of *London*, to the Memoirs of the Royal Academy of Sciences at *Paris*, and to the other Authors who have written upon this Subject.

The Glaſs-Tube commonly us'd in electrical Experiments is about three Foot and an half long, an Inch and an half in diameter, and about $\frac{1}{12}$ of an Inch thick, open at both Ends, but ſometimes hermetically ſeal'd at one End, *viz.* that which is furtheſt from the Hand. Theſe Proportions are not ſtrictly neceſſary: only this Bigneſs is moſt convenient for the Hand; and when the Thickneſs is leſs than $\frac{1}{12}$ of an Inch, the Electricity is ſooner excited by Friction, but it does not laſt ſo long as when the Tube is thicker. You muſt hold the open End of the Tube (when it has one End ſhut) in the left Hand; and it

muſt

muſt be rubb'd up and down ſeveral times with the right Hand, holding dry Paper or dry Cloth in your Hand: but the Hand alone is much better, provided it be very dry, which ſeldom happens. It is alſo very proper to warm the Tube a little by the Fire to dry it before you begin to rub it; but abſolutely neceſſary to do it when the Air is moiſt, which is the moſt inconvenient Weather for making theſe Experiments. Dry and cold Air is the moſt proper, for then very little Friction is ſufficient; but you muſt rub the Tube a great while, and the Electricity continues but a little while when the Weather is moiſt.

To know whether the Tube has been rubb'd long enough, and the Electricity ſufficiently excited, you muſt ſtrike your Fingers croſs-wiſe near the Tube, but without touching it, at the Diſtance of about half an Inch, and you will hear a ſnapping from the electrical Effluvia, which going from the Tube ſtrike againſt the Fingers and rebound again to the Tube. Then you may be ſure that the Tube is in a Condition to produce its Effects, being fully prepar'd for making electrical Experiments; but you muſt not

ſorget to rub the Tube anew (at leaſt once) after it has been made to ſnap in paſſing the Fingers near it: becauſe at the Place where the Fingers paſs'd by and made a ſnapping, the Electricity of the Tube has been deſtroy'd. If you move your Fingers long-wiſe from one end of the Tube to the other (but all the while without touching it) you will hear a continued ſnapping, like a diſtant Noiſe of Thorns burning in a Fire. If the Room be darken'd when you make theſe Experiments, you will ſee Sparks of Light where-ever the Tube ſnaps; and likewiſe a Light following the Hand that rubs the Tube.

Some EXPERIMENTS *made with the* Tube *above deſcrib'd, ſufficient to ſhew the Manner in which the Bodies which are* electrick per ſe, *act.*

AS it wou'd require a whole Volume to recount all the electrical Experiments that have been made, and thoſe that are made every day; I ſhall only mention here ſome of the moſt remarkable Experiments which will ſerve

ſerve to explain the Principles that I lay down; by which one may always certainly foretell what will happen to any Body which is excited to Electricity, or any other Body which receives the Electricity communicated from a Body in which Electricity has been excited.

EXPERIMENT I.

Having laid ſmall Pieces of Leaf-Gold or Leaf-Braſs, or any other ſmall Bodies upon a little Stand whoſe Surface or Top was ſeven or eight Inches Diameter, the rubb'd Tube having been brought within a Foot or two of the Stand, the ſmall Bodies were alternately attracted and repell'd for ſome time; and ſometimes they were repell'd from the Tube as they were coming towards it, even before they had touch'd it, and alſo came back from the Stand towards the Tube without having touch'd the Stand, jumping backwards and forwards with great Swiftneſs.

EXPERIMENT II.

Having tied a Down Feather to the top of a wooden Broach or Skewer of about ſix or ſeven Inches in Height, and fix'd upright upon a Foot; when you bring the excited Tube near it, all the Fibres of the Feather ſtretch out towards the Tube; but as ſoon as you remove the Tube, the Fibres of the Feather turn back and ſtick ſtrongly to the Skewer. If you bring your Finger near to the Feather while its Fibres are tending towards the Tube, being attracted by it, the Finger will repel them; but as ſoon as you remove the Tube, they are attracted by the Finger. If you cover the Feather with a Glaſs Recipient (ſuch as are us'd on the Air-Pump) that is very dry, the Tube will attract the Feather in the ſame manner thro' the Glaſs: and this happens even when the Recipient has been exhauſted of its Air by the Pump. When the Tube is rubb'd near the Recipient, whether it be full of Air or empty, the Fibres of the Feather follow the Motion of the Hand along the Tube, riſing and falling upon the Broach or Skewer.

Experiment III.

Without making uſe of the Tube, if you rub the Recipient that covers the Feather, with both Hands, the Fibres of the Feather will ſtretch themſelves out towards the Glaſs like the Rays of a Sphere. If you rub but with one Hand, the Fibres will ſtretch themſelves towards that Part of the Glaſs which is rubb'd: and then when you blow againſt the Glaſs, thoſe Fibres will be repell'd notwithſtanding the Interpoſition of the Glaſs; which happens alſo when you ſtrike the Air with the Hand towards the Feather without touching the Recipient.

Experiment IV.

After the Tube has been rubb'd, if any Aſſiſtant lets go a Down Feather in the Air at the Diſtance of a Foot or two from the Tube, the Feather will jump towards the Tube with an accelerated Motion, and adhere to it for ſome time; and then of a ſudden it will be repell'd from the Tube, and will fly about in the Air in ſuch manner, that the

nearer

nearer you bring the Tube to it, the more it will be repell'd, till it has touch'd ſome other Body; and then it will be drawn again by the Tube; which after ſome time will drive it away again. Sometimes when the Finger is held at eight or ten Inches from the Tube, the Feather will jump from the Tube to the Finger and from the Finger to the Tube thirty or forty times together.

Experiment V.

If a String of any kind be ſtretch'd horizontally, and from that String you hang a Thread of Silk about three Foot long and very dry, and to the lower End of that Thread you faſten a Down Feather; then at the Diſtance of about two or three Feet hang up another Feather, but by a flaxen Thread; the rubb'd Tube being brought near will attract the firſt Feather, which, when it has adher'd to it a little while, will fly from the Tube, and then be repell'd by it every time the Tube is brought near, till it has touch'd ſome other Body, as in the Fourth Experiment; and then it will be attracted anew. But the Feather which is ſuſpended by the flaxen Thread will

always be attracted at the Approach of the Tube, and never repell'd. N. B. *If you wet the ſilken Thread, the Feather hanging at it will be repell'd no more, but always attracted by the Tube.*

Experiment VI.

When the excited Tube is brought near your Face, you will feel the electrick *Effluvia* like ſmall Hairs which will ſtrike your Eyes and Cheeks, draw the Hairs of your Eye-brows, and make a ſmall crackling Noiſe.

Experiment VII.

If you make uſe of a Tube which is hermetically ſeal'd at one End, and has at the other End a Braſs Ferril with a Screw, by which means you may pump out the Air from it: If you rub the Tube after you have exhauſted the Air, it does not attract any more, nor give any Light outwardly; but it gives much more Light within. Then if, by opening the Cock a little way which is faſtened to the Tube, you let in the Air ſlowly

whilſt you rub the Tube, the Light diminiſhes, and being interrupted by the Air as it comes in, looks like Lightning at a Diſtance, till all the Air is come in, and then there is no more Light within; but the Light goes all to the Outſide, and the Attraction returns.

Experiment VIII.

If upon the Stand mention'd in the Firſt Experiment you ſet up edgewiſe two little Boards about nine Inches long, ſix Inches wide, and three quarters of an Inch thick (two ſmall Octavo Books will do as well) parallel to each other, and about the Diſtance of ten Inches aſunder; little Pieces of Leaf-Gold or Braſs laid upon the Stand between thoſe Boards, will not be attracted by the rubb'd Tube held near them, till it be brought quite between the ſaid Boards, as near to the Stand as half the Diſtance of the Boards from each other: that is, when the Tube is ſo held that a Circle deſcrib'd round the Axis of the Tube with the Diſtance that is between that Axis and the Stand, paſſes between the Boards or Books without touching

them. But when the rubb'd Tube being held horizontally at the Diſtance of a Foot from the Stand, ſeems to have no Virtue, becauſe the Leaf-Gold has no Motion; if an Aſſiſtant ſnatches away the Boards all on a ſudden, the Pieces of Gold will be attracted and repell'd ſeveral times, without giving any new Friction to the Tube.

Experiment IX.

When the Air is very dry, and the rubb'd Tube can attract the Leaf-Gold laid on a ſmall Stand, to the Diſtance of three Foot or beyond; if the ſame Leaf-Gold be laid upon a Table or any large Surface, you muſt bring the excited Tube very near before it can produce its Effect.

Experiment X.

When the Air is moiſt, the fourth Experiment does not ſucceed well; for after the Feather in the Air has been ſome time driven about by the Tube, it comes back of itſelf to the Tube without having touch'd any other Body; and ſometimes after having adhered

to the Tube towards the middle of it, it flies off of it and comes again immediately to the Tube, ſticking to that Part of it which is fartheſt from the Hand. It happens alſo, when it is very dry and the Tube repels the Feather, (after having attracted it) to the Diſtance of two or three Foot; that if you wet the Top of the Tube at the End for the Length of ſix or ſeven Inches, the Feather will come and ſtick to that End of the Tube without having touch'd any other Body.

Experiment XI.

Having fill'd with Water a ſmall Drinking-Glaſs of about an Inch Diameter, when you bring the rubb'd Tube near it, the Water riſes in a little Hill accumulated at the Edge of the Glaſs, ſometimes jumping towards the Tube in a little Jet, ſo ſmall that you can hardly ſee it, tho' you may find the Tube wholly wet with it. One may alſo obſerve that this accumulated Water riſes in the Shape of a ſmall Cone whoſe Axis is ſometimes ſtretch'd out horizontally towards the Tube, then ſnaps and falls down again flat upon the reſt of the Water. If this Experiment be made

made in the dark, a Flaſh of Light accompanies the ſnapping.

EXPERIMENT XII.

If by means of an artificial Fountain (in which Air is condens'd upon the Water to make it ſpout) you play a ſmall Jet of about the 40th part of an Inch Diameter, upwards or downwards: the rubb'd Tube being brought near, the Jet will bend towards the Tube at the Diſtance of a Foot; and if the Tube be brought nearer, the Jet being wholly drawn away by the Tube, is chang'd into a Dew upon the Tube, ſo that it adheres to the Tube in little Drops, provided the Jet be not made to ſpout with too much Force.

Here follow ſome remarkable Effects of Electricity *communicated to Bodies which are* Non-electricks per ſe.

EXPERIMENT XIII.

Having ſtretch'd horizontally a Packthread or hempen String to the Length of about twelve hundred Foot, at the End of which was

was ſuſpended an Ivory Ball of about an Inch and an half in Diameter; this Ball has drawn and repell'd Leaf-Braſs or Leaf-Gold when the rubb'd Tube has been brought near the other End of the String: the Thread of Tryal being alſo brought near to the ſaid Ball was attracted by it.

N. B. *All the Supporters of this String muſt be* Electricks per ſe, *whether they be Hair-Ropes, Fiddle-ſtrings, or Cat-guts, Ribbons, Strings of Silk, Glaſs Tubes, long Bodies of Sulphur or of Reſin*, &c. and all thoſe Bodies very dry. We ſhall hereafter call the non-electrick Body, which being ſtretch'd out in length, receives the communicated Electricity, the *Conductor of Electricity*; and the Bodies on which it reſts, or from which it is ſuſpended, the *Supporters of the Conductor of Electricity*.

EXPERIMENT XIV.

If you wet the Conductor of Electricity, the Experiment will ſucceed the better; but you muſt take care not to wet the Supporters: for if the leaſt of the Supporters, for

example the firſt, be wet, it becomes a *Non-electrick*, and thereby conducts the Electricity that comes to it to the Body which it touches, and from thence to the Ground, where it is loſt, not ſuffering it to go any farther upon the Conductor. If you examine the Supporters by bringing the Thread of Tryal near them, you will find them to be electrick about five or ſix Inches on each ſide of the Conductor, more or leſs as the Air is more or leſs moiſt; the Supporters being as it were ſaturated with the communicated Electricity in a little ſpace near the Conductor.

EXPERIMENT XV.

If inſtead of ſtretching the Conductor at length, you carry it backwards and forwards upon the Supporters ſeveral times in parallel Lines, provided thoſe Lines be diſtant enough from each other (for example about three Foot diſtant) the communicated Electricity will run as far backwards and forwards as if the String had gone ſtreight on, and will give as much Virtue to the Ball at the End of the Conductor.

EXPERIMENT XVI.

If the Conductor is ſtretch'd out in the form of a Star, the electrical Virtue will be perceiv'd at all the Points of it. For example, if the Conductor be ſtretch'd from the firſt Supporter about forty Foot in length, and then divided into five Branches of twenty Foot long each, ſeparated from each other in the manner of a Star, with a Ball at the End of each String or Point; when you bring the rubb'd Tube near the beginning of the Conductor, you will find by Threads of Tryal that all the Balls have receiv'd the Electricity at the ſame time.

EXPERIMENT XVII.

Having ſupported, or ſuſpended by electrick Bodies, an Iron-Bar nine Foot long, which had three Branches pointed at the End at the Diſtance of two Foot from each other, the Electricity communicated from the Tube at the other End, was felt at the ſame time by the Cheeks of three Perſons which brought their Faces near the three Points, by a ſnap-

ping Noiſe, a Pricking, and a Flaſh of Light ſeen in the dark.

Experiment XVIII.

Having ſuſpended a Man horizontally (as in a ſwimming Poſture) by two Hair Ropes, that Man becomes a Conductor of Electricity. That which he receiv'd by the Approach of the rubb'd Tube brought near the Soles of his Feet, made him ſtrongly attract the Thread of Tryal and Leaf-Braſs with his Head and his Hands; and likewiſe with his Feet, but very weakly. But when the Tube is brought near his Head, then his Feet attract very ſtrongly. Then if the Man (when the rubb'd Tube is brought back to his Feet) holds out his Finger near the Face of any Perſon ſtanding by, a Flaſh of Light will fly from the Finger, a ſnapping Noiſe will be heard, and both the Man on his Finger and the Aſſiſtant on his Cheek will feel a Pricking at the ſame time. In the ſame manner, if any one moves the Hand croſs-wiſe near the Arms or Legs of the Perſon ſuſpended, they will both feel the ſame Pricking: and if one puts an Iron-Bar near the Perſon ſuſpended, he

will hear the Snapping and feel the Pricking. What is remarkable is, that if the Man hanging horizontally has on a Cloth Coat that is quite dry, you will feel no pricking when you paſs your Fingers near the Coat, and the Thread of Tryal will be but weakly attracted by it, nay ſometimes not at all.

N. B. *Any other Animal ſuſpended will produce the ſame Effect.*

EXPERIMENT XIX.

The Electricity receiv'd by the Conductor advances from one End of it to the other in a kind of Cylindrick *Vortex*, as may be ſeen by the following Experiment. Having carried a Packthread Conductor of Electricity thro' the middle of a wooden Hoop fix'd vertically upon an open Glaſs Cylindrick Recipient, its Plane being at Right-Angles with the Packthread: when you bring the rubb'd Tube near to one End of the Packthread, not only the Ball at its other End becomes electrick, but alſo the whole Circle or Hoop tho' ſix Foot diſtant from the Ball; for the ſaid Hoop attracts the Thread of Tryal by all its Parts.

Experiment XX.

Having ſuſpended the before-deſcrib'd artificial Fountain, by Fiddle-ſtrings, and having open'd its Cock to make its Jet play, horizontally, or obliquely, or vertically upwards; if the rubb'd Tube be brought near the Body of the Fountain, the Electricity will be communicated to the whole Jet, which will then in every part of it attract the Thread of Tryal; the Jet becoming then a Conductor of Electricity.

Experiment XXI.

If you ſuſpend two or three Iron-Bars in the ſame horizontal Line, at the Diſtance of ſix Inches from one another, the Electricity communicated by the rubb'd Tube to the End of one of the Bars will go on from the one to the other quite to the End of the laſt Bar, where a Pricking will be felt, a Noiſe heard, and a Flaſh of Fire ſeen. If the Air is dry, the Electricity will jump from one Bar to another at a greater Diſtance; but in moiſt

Weather

Weather the Bars muſt not hang above an Inch diſtant from each other.

Experiment XXII.

Having by a Fiddle-ſtring ſuſpended a Bough of a Tree which had about four or five hundred Leaves, upon the Approach of the rubb'd Tube all the Leaves attracted the Thread of Tryal. Then having ſtretch'd a Rope from that Bough to another ſuſpended in the ſame manner at the Diſtance of thirty Foot from the firſt: the Tube brought to one of the Boughs gave Electricity equally to the two. Afterwards ſubſtituting a very ſmall flaxen Thread, inſtead of the Rope, from one Bough to the other; the Electricity was communicated as eaſily as before.

Experiment XXIII.

When a ſmall String of white Silk of about the ſame Size as the flaxen Thread, was ſtretch'd from one Bough to the other, the Electricity communicated to one Bough did not go to the other: but having wet the

Silk,

Silk, it conducted the Electricity to the other Bough as well as the flaxen Thread.

Experiment XXIV.

Having mix'd Bees-Wax with about eight times its Quantity of Refin to hinder it from being brittle, and having melted and caft the whole in a round Mould of about ten Inches Diameter and three Inches deep, fpreading from the Bottom upwards, a Cake was made, which when cold appear'd to be a Body electrick *per fe*. This Cake being warm'd, rubb'd, or patted with the Hand, attracts the Thread of Tryal; and fometimes does the fame without any thing being done to it, but expofing it to the Air. If you fet this Cake on the Ground, and a Man ftands upon it, ftretching out his Arms horizontally, when the rubb'd Tube is applied to one of his Hands the whole Body of the Man will be impregnated with Electricity; but that Virtue will be moft fenfible at that Part which is moft diftant from the Tube, which is the Man's oppofite Hand; to which if an Affiftant bring his Face near, he will feel the Pricking, fee the Flafh of Fire, and hear the

Snapping;

Snapping; the Man, render'd electrical, feeling, feeing, and hearing the fame. If another Man ftanding upon another Cake of Refin (or a Cake made of Sulphur, or any other Subftance that is electrick *per fe*) at a diftance, as for example at thirty Foot from the firft Man, holds in his Hand the End of a Packthread or any other non-electrical String, of which the firft Man holds the other End; the Electricity communicated to the firft Man by the Application of the rubb'd Tube, will be communicated to the fecond, who makes it be felt by thofe that come near his Hand that is moft diftant from the Tube. But if the leaft flaxen Thread falls from the Packthread, or from the Clothes of either of the Men, fo as to touch the Ground, the Electricity will not go beyond that Thread; but running down in that Place along the Thread, is loft upon the Ground or the Earth. If fifty Men ftood upon as many electrical Cakes, communicating one with another by their Hands, or by any Non-electricks, the laft will be ftrongly impregnated with the Electricity that the rubb'd Tube gives to the firft.

N. B. This has been tried with a dozen Men; and it is not known how far this communicated Electricity may be carried.

Electricks *per se*, whilst they are in a State of Electricity, can receive no communicated Electricity (or receive but very little of it at their Ends) from the Tube or other Electricks *per se* excited; and cannot then become Conductors of Electricity: but it is easy to change them into Non-electricks, and then they will become Conductors of Electricity like others.

The following EXPERIMENTS *shew how Electricks* per se *become Non-electricks.*

HAVING suspended horizontally by dry Silks a Glass-Tube six or eight Foot long, also very dry, at the End of which is fasten'd an Ivory-Ball, you cannot give that Ball any Electricity by applying the rubb'd Tube to the other End of the suspended Tube: but as soon as you wet the suspended

Tube

Tube from one end to the other with a Spunge, that Tube conducts the Electricity, and the Ivory-Ball attracts.

Experiment XXVI.

As it has been ſhewn that communicated Electricity, as it is conducted, jumps from one non-electrick Body to another; it is not neceſſary that the Moiſture of the ſuſpended Tube ſhould be continuous; for after the Tube has been well dried, if you ſuſpend it anew, and find that it cannot receive or conduct any more Electricity, you need but to blow thro' it with your Mouth, and the Moiſture of your Breath will render it non-electrick, whereby it will again receive and conduct Electricity, the Ivory-Ball acting upon ſmall Bodies as before. Sometimes the changing of Bodies from electrick into non-electrick happens only by the changing of the Condition of the Air, when from being dry it becomes moiſt.

Experiment XXVII.

Having ſtretch'd a Packthread Conductor of Electricity to a Length of twenty Foot, upon three electrical Supporters, of which the middle one was a Stick of Sealing-wax, the Electricity receiv'd from the rubb'd Tube applied to one end of the Conductor appear'd at the Ball ſuſpended at the other end: but when inſtead of the Ball the Stick of Wax that had been us'd as a Supporter was ſuſpended at the end of the String, the Thread of Tryal has not been attracted by this ſuſpended Wax, except at its upper end joining to the Packthread; but upon wetting the Wax, it attracted the Thread of Tryal ſtrongly in all its Length. Then replacing the Ball, and reſtoring the wet Wax to its Place where it was before a Supporter of the Conductor of Electricity, the communicated Electricity was ſtopp'd at the Wax, and wou'd go no farther till the Wax was dried.

There are Bodies which one wou'd take for Non-electricks *per ſe*, becauſe every time they are ſuſpended by electrick Bodies, they receiv

receive (and become Conductors of) the Electricity communicated by the excited Tube: but if you dry them well at the Fire; and rub them very much, they may be made electrick. These Bodies, and those which from being strongly electrick are become non-electrick by Moisture, will indeed receive Electricity from the rubb'd Tube, and conduct it to their Ends, but in less Quantity, and do not accumulate it so strongly as the Non-electricks *per se*. This is the Reason that we see less Light at the End of a wooden Bar than at the End of an Iron one; and that we hardly feel any pricking at the End of the first, tho' both have receiv'd their Electricity from the same Tube.

It has been thought that Animal Substances were electrick, and Vegetable Substances were not; because those that made the Experiments have generally succeeded in making use of Animal Substances for Supporters, and Vegetable Substances for Conductors of Electricity: but what is true in that Supposition, is only, that because Silks, Fiddle-strings, Strings of Woollen, or Hair, are very dry Substances; and Vegetables are

usually

usually moist. For if you wet those Animal Substances, they all become non-electrick, and can no more serve as Supports for the Conductors of Electricity, but will receive it when communicated, and conduct it. Likewise when the Packthread which is usually made use of to conduct Electricity very far, has been rubb'd over with Glue and is very dry, it receives Electricity no longer, till you wet it to make it become non-electrick. A Man, or any other Animal upon a Cake of Resin, or suspended by Strings of Hair or Silk, is always non-electrick; but is only so because he always has Moisture: for when his Cloaths are dry, they are electrick *per se*, and therefore do not snap. *See the 18th Experiment.*

When we consider the different Circumstances of several Electrical Experiments, there seems to be a sort of Capriciousness, or something unaccountable in those Phænomena not to be reduc'd to any Rule. For sometimes an Experiment which has been made several times successively, all at once will fail; or have a quite contrary Success, tho' the Circumstances seem to be the same. But I hope that the Conclusions which I have drawn from

from the Consideration of several principal Experiments, are so general, that they will serve as Rules to explain all the Oddness which seems to accompany the electrical Experiments, and to foretell certainly all that must happen in the Approaches and Combinations of Bodies in respect of Electricity excited, or receiv'd by Communication. Before we give Examples of the Explication of the most remarkable Phænomena, we must make mention of some Experiments, from which among others are deduc'd two other general Propositions to be added to what I have said of Electricks *per se*, and of Non-electricks *per se*; and of the manner that the one and the other acquire or lose Electricity.

Experiment XXVIII.

Having suspended horizontally by two silken Threads, about four Foot long each, a small Glass-Tube very dry and a little rubb'd; if you apply to it long-wise the great rubb'd Tube, it will repel the little Tube till its Silks become inclin'd to the Horizon from being perpendicular before. Then having wet the little Tube, when you bring the great

great rubb'd Tube near it, it is attracted by the great Tube till its Silks are remov'd from the Perpendicular inclining near to the great Tube. From this Experiment, and many others of the ſame kind, may be concluded that Bodies which are electrick *per ſe* being excited to Electricity repel all other Bodies that have Electricity; but attract them as ſoon as they have loſt their Electricity, and ſo *vice verſâ.*

EXPERIMENT XXIX.

Having ſuſpended a Down Feather by a ſilken Thread, as in the fifth Experiment, Sealing-wax well rubb'd produces the ſame Effect as the Tube, but more weakly, drawing the Feather; and when once it is ſeparated from the Wax, the Wax repels it continually till the Feather has touch'd ſome other Body. But what is different here, is, that when the Feather is in a State of Repulſion in reſpect of the Wax, the rubb'd Tube attracts it; and when the Tube has given the Feather its repulſive State, then the rubb'd Wax attracts it: which ſhews that the Electricity of Glaſs is different from the Electricity

city of Wax. The late *Monſ. du Faye*, Intendant of the *King of France*'s Gardens at *Paris*, was the firſt that obſerv'd that there are two ſorts of Electricity; and in a *Memoire* where he ſpoke of it, he ſhew'd the Way of finding what kind of Electricity belongs to any electrick Body whatever.

To ſhew the Uſefulneſs of theſe Rules, Laws, or Principles of Electricity; we will make uſe of them to explain the odd Circumſtances of ſome Experiments: as for example,

1°. Why don't we feel a pricking on the Eyes when the rubb'd Tube is brought near to the Face; ſince the Ends of the Finger of a Man made electrick, or of an Iron-Bar made electrick, makes the Face that is brought near it feel a very ſenſible pricking?

Anſwer. Becauſe the electrical Effluvia coming from the Tube to the Face, are only thoſe which come from that Part of the Tube which is brought near the Face; whereas the Bar gives accumulated Effluvia of the Electricity which it has receiv'd from

all its Length, and from the Tube at ſeveral Applications.

2°. What is the Reaſon that the Feather which, having been attracted by the Tube, is ſeparated from it, and then always repell'd till it has touch'd another Body?

Anſwer. Becauſe Electricks repel one another. For which Reaſon the Feather, as ſoon as it has been impregnated with the Electricity of the Tube, is driven from it; which continues as long as the Feather keeps its Electricity, which it loſes as ſoon as it has touch'd another Body; then being again become non-electrick, the Tube attracts it anew; thus alternately receiving and loſing Electricity, it jumps ſeveral Times from the Tube to the Finger and back again. *See Experiment* IV.

3°. What is the Reaſon this does not happen when the Air is moiſt?

Anſwer. Becauſe the Feather being become electrical, draws the moiſt Particles that ſwim in the Air, and thereby loſing its Electricity,

is again attracted by the Tube. The Tube alſo at the Place which has been the leaſt rubb'd loſes its Electricity by the moiſt Particles which it draws out of the Air, and becoming non-electrick in that Place (as it happens when it is made wet on purpoſe) draws the Feather before it has loſt its Electricity.

4°. Whence comes it that a Conductor of Electricity does ſometimes, without changing any thing, loſe its Virtue, and ceaſe to conduct Electricity, tho' you continue to rub the Tube at one of its Ends?

Anſwer. Becauſe ſome one of the Supports of the Conductor has imbib'd the Moiſture of the Air, by which it is become non-electrick. This has happen'd to me in making uſe of a long Piece of Hat by way of Support, one Day that the Weather was moiſt. This Liſt of Hat, having been warm'd, ſupported the Conductor well and effectually; but in half an Hour having imbib'd ſome Moiſture from the Air, it ſtopp'd the Courſe of the Electricity. When we make uſe of Glaſs-Tubes for our Supporters, this happens ſometimes if the Air be very moiſt.

5°. Whence does it happen that the Feather on the Skewer or Broach of Experiment 2. ſtretches out its Fibres, ſeparating them from each other by the Attraction of the Tube, and that the Finger repels them when the Tube is brought near to the Feather, but attracts them when the Tube is remov'd ?

Anſwer. The Fibres of the Feather extend like the Rays of a Sphere, becauſe being become electrick they repel one another. The Finger repels them becauſe it receives Electricity from the Tube; but when the Tube is remov'd, the Finger loſes its Electricity, and then it draws the Feather which is ſtill electrical.

6°. Whence does it happen that in the Eighth and Ninth Experiments the rubb'd Tube attracts the Pieces of Leaf-Gold or Braſs much farther, when they are laid upon an *inſulated* Stand, than when they are laid upon a Table, or when they are ſhut up on two ſides upon the Stand by Books or Boards ſet edge-wiſe.

Anſwer.

Anſwer. Becauſe the electrical Effluvia flying off from the Tube return again in a Circle towards it, and carry with them all the little non-electrick Bodies which they meet in their way at their Return; but if thoſe non-electrick Bodies are too heavy to be brought towards the Tube, the electrical Effluvia adhering to them, and ſliding along thoſe Bodies, loſe themſelves when the Bodies are not *inſulated* or terminated by Electricks: but when they are, the Electricity or electrick Effluvia accumulate at the Ends of thoſe Bodies which are the fartheſt from the Tube. N. B. *The Tube attracts the Feather when it is cover'd with a Glaſs Recipient, becauſe the electrical Emanations like Light (of which they ſeem to participate), eaſily penetrate electrick Bodies which do not hinder their Circulation.*

For want of having eſtabliſh'd Rules (that is Principles deduc'd from Experiments) by which one may explain the moſt odd *Phænomena*, People have imagin'd ſeveral Properties to belong to the Electricity of ſome Bodies, which at laſt Experience has diſprov'd. As for example, That Bodies of different Colours

receiv'd

receiv'd more or leſs Electricity; which happen'd only becauſe when the Experiment was firſt try'd, ſome happen'd to be more or leſs moiſt than others. It has alſo been thought by ſome, that ſmall electrick Bodies ſuſpended by a fine Thread circulated round a Ball of Iron laid upon a Cake of Reſin, after the manner of the Planets round the Sun; which only happen'd becauſe the Man that made the experiment had a great mind that the Thing ſhould be ſo, and communicated that Motion to the little Body ſuſpended without knowing that he did it: for this did not happen to any other Perſon that held the Thread and pendulous Body without the ſame Inclination. The ſame may be ſaid of ſeveral other Circumſtances which are not worth mentioning.

Though I have not endeavour'd to gueſs at the Cauſe of Electricity, or its Uſe in the phyſical World; not having *Phænomena* to eſtabliſh them ſufficiently, I hope to have ſatisfy'd the Gentlemen of the Academy as to what they can expect upon this Subject, in giving Rules or Principles to explain or account for the electrical Experiments that have been made

made hitherto, and perhaps ſuch as may be made hereafter.

Yet if Conjectures are deſir'd, here follow ſome:

I ſuppoſe Particles of pure Air to be electrick Bodies always in a State of Electricity, and that *vitreous* Electricity.

1*ſt*, Becauſe Particles of Air repel one another without touching, as has been deduc'd from Experiments and Obſervations.

2*dly*, Becauſe when the Air is dry, the Glaſs Tube rubb'd (or only warm'd) throws out its *Effluvia*, which the Air drives back to the Tube; from whence they dart out anew, and ſo move backwards and forwards with a vibratory Motion, which continues their Electricity.

3*dly*, Becauſe the Feather made electrick by the Tube, and darted from it, keeps its Electricity a long time in dry Air; whereas when the Air is moiſt, the moiſt Particles which are non-electrick, floating in the Air, and being

being attracted by the Feather, adhere to it, and ſoon make it loſe its Electricity; which alſo happens even to the Tube in a little time.

From this Conſideration it will be eaſy to account for a famous Experiment of the late Mr. *Hauksbee*, which is this: —

Having pump'd out all the Air from a Glaſs Globe, he caus'd it to turn on its Axis very ſwiftly by means of a Rope with a Wheel and Pulley; then rubbing the Glaſs with his Hand during its Motion, there appear'd a great deal of Light of a purple Colour within the Globe, without any Light or Attraction obſerv'd on the Outſide of the Glaſs, which is obſerv'd when the Air has not been pump'd out. Then turning the Cock ſo as to readmit the Air gently into the Globe during its Motion, the Light was broken and interrupted, diminiſhing gradually, till at laſt it appear'd only on the Outſide of the Glaſs, where it was accompanied with Attraction. Does it not appear to be, that at firſt the external Air, by its Electricity, drives back the electrick Effluvia of the Glaſs, which go then to the

Inſide

Inside of the Globe, where there is the least Resistance? For we observe that as the Air comes in, it repels the electrick Effluvia, that go inwards no longer when all the Air is come in. If the Fact be so, as the Experiment shews, is not my Conjecture prov'd, *viz.* that *the Air is Electrical?*

In the Reverend and Learned Dr. *Hales*'s *Vegetable Staticks*, several of his Experiments shew, that Air is absorb'd, and loses its Elasticity by the Mixture of sulphureous Vapours, so that four Quarts of Air in a Glass Vessel will, by the Mixture of those Effluvia, be reduc'd to three. Will not this Phænomenon be explain'd by the different Electricity of Sulphur and Air. The Effluvia of Sulphur being electrick repel one another: and the Particles of Air being also electrick, do likewise repel each other. But the Air being electrical of a vitreous Electricity, and Sulphur of a resinous Electricity, the Particles of Air attract those of Sulphur, and the *Moleculæ* compounded of them becoming non-electrick lose their repulsive Force.

It has for a great while been thought that watery Vapours that rise in the Air to form

Clouds, uſed to riſe, becauſe the Water which is of itſelf ſpecifically heavier than Air (being form'd into little hollow Spherules or Bubbles fill'd with an *Aura*, or thinner Air than the ambient Air) in this new State made a Fluid of little Shells ſpecifically lighter than the ambient Air in which it muſt riſe like Smoke; but Philoſophers are no longer of that Opinion; and ſuch as have implicitely come into it, may find it refuted in the *Philoſophical Tranſactions*, Numb. 407.

Now may not this Phænomenon of the Riſe of Vapours depend upon Electricity in the following manner?

The Air which floats at top of the Surface of the Water is electrical, and ſo much the more as the Weather is hotter. Now in the ſame manner as ſmall Particles of Water jump towards the electrick Tube, may not theſe Particles jump towards the Particles of Air which have much more ſpecifick Gravity than very ſmall Particles of Water, and adhere to them? Then the Air in motion having carried off the Particles of Water, and driving them away as ſoon as it has made them

electri-

electrical, they repel one another, and alſo the Particles of Air. This is the Reaſon that a cubic Inch of Vapour is lighter than a cubic Inch of Air; which would not happen if the Particles of Vapour were only carried off in the Interſtices of Air, becauſe then a cubic Inch of Air loaded with Vapour would be made ſpecifically heavier than an Inch of dry Air; which is contrary to Experiments, which ſhew us by the Barometer, that Air which is moiſt or full of Vapours, is always lighter than dry Air.

The END *of the* DISSERTATION.



CON-



CONCERNING The ſeveral AUTHORS Who have treated of ELECTRICITY.

THE Electricity of Amber, precious Stones, and ſome few other Bodies, was known long ago, and has been mentioned by ſeveral Authors, ſuch as *Gaſſendus*, *Gilbert*, *Digby*, Sir *Thomas Brown*, and many others; but as what has been ſaid by many Authors that have written long ago, has been repeated by others, I ſhall not mention ſeveral that have ſpoken ſuperficially on the Subject, and written about it when but few electrical Phænomena were known.

The

The firſt worth mentioning particularly is Mr. *Boyle*, in whoſe Books you will find an account of ſeveral Phænomena of Electricity. See Dr. *Shaw*'s *Abridgment*, Vol. I. from Page 397, to Page 510.

The next was Mr. *Francis Haukſbee* F.R.S. who made a great many new Experiments on the Electricity of *Glaſs*, *Amber*, *Sealing-Wax*, and ſeveral other Subſtances, and their Production of Light upon their Attrition in the Dark; whether *in vacuo*, or in the open Air. See his Book of *Phyſico-Mechanical Experiments*, printed at *London* in the Year 1709; from Page 17, to Page 69.— From Page 109, to Page 127.— And from Page 131, to 139.

Afterwards Mr. *Stephen Gray* made ſeveral new and ſurprizing electrical Experiments, and purſued his Enquiries and Experiments for ſeveral Years till he died in the Year 1736: An Account of which may be found in the *Philoſophical Tranſactions*, N° 366. N° 417. N° 422. N° 431. N° 436. N° 439. N° 441. N° 444.

Monſ.

Monſ. *Du Faye* alſo made ſeveral new and curious Experiments upon this Subject, to be met with in the *Hiſtory* and *Memoirs* of the *Royal Academy* of Sciences at *Paris*, for the Years 1733, 1734, and 1735; and in our *Philoſophical Tranſactions* of *London*, in a Letter that he wrote to his Grace the Duke of *Richmond*, N° 441.

Several Perſons in their Philoſophical Works have quoted ſome of theſe Experiments, but none ſo fully as that ingenious and accurate Philoſopher *Petrus van Muſchenbroek*, Profeſſor of *Experimental Philoſophy* and *Mathematicks* at *Leyden*; who has written a whole Chapter about it in his *Eſſays de Phyſique* &c. *imprimés a* Leyden *chez* Samuel Luchtmans 1739. See the 17th Chapter of his firſt Volume, from Page 254, to Page 272; where he gives a very particular account of moſt of the electrical Experiments made within theſe twenty Years, till the Time that he writes; except ſuch as had not been made, or had not been publiſhed before that Time.

The

The reſt of the electrical Experiments made ſince Mr. *Stephen Gray*'s Death were made by *Granvil Wheeler* Eſq; mentioned in the *Philoſophical Tranſactions* N° 253; and by myſelf N° 454. and N° 462; beſides ſome others, which I lately ſhewed the Royal Society: An Account of which is not yet publiſhed, but will be in the *Tranſactions* this Winter. Indeed a few electrical Experiments, made by Mr. *Gray* and my ſelf many Years ago, are mentioned in the Firſt Volume of my *Courſe of Experimental Philoſophy*, from Page 17, to Page 21.



A LETTER FROM PRESIDENT *BARBOT*, &c. TO DR. *DESAGULIERS*, &c.

A MONSIEUR,

Monſieur le Docteur *Deſaguliers*, Chaplain de ſon Alteſſe Royale le Prince de *Galles*, Membre de la Societé Royale de *Londres*.

A LONDRES.

Bordeaux, 3 *Aouſt* 1742.

MONSIEUR,

JE vous apprends avec bien de la joye que l'Academie de Bordeaux vient de donner le Prix à la Diſſer-

Dissertation que vous luy avès Envoyée sur l'Electricité, ce qui a pour devise, *Sero sapiunt Phryges.* Cét avantage est d'autant plus flateur que vous l'avès remporté sur un très grand Nombre de Rivaux.

Comme ce Prix consiste en une Medaille d'Or, je vous prie de charger quelqu'un a Bordeaux de la recevoir en votre Nom & d'en donner une quittance valable. Je suis ravy Monsieur d'étre le premier a vous proclamer vainqueur, j'auray l'honneur des vous envoyer des Exemplaires de votre Dissertation desqu'elle sera imprimée. Je ne doute pas que le Public ne la lise avec le même gout que nous l'avons Couronnée. Vous l'avés accoutumé depuis longtemps a recevoir tous vos Ouvrages

avec applaudiſſement. J'ay l'honneur d'étre avec une parfaite Eſtime & un Attachement reſpectueux,

MONSIEUR,

Votre tres-humble

& tres-obeïſſant Serviteur.

BARBOT.

MON addreſſe eſt à Mr. le Preſident BARBOT, Secretaire perpetuel de l'Academie de Bordeaux, ſur les foſſés du Chapeau Rouge, à Bordeaux.

FINIS.

1. A Treatife of the Five Orders in Architecture. To which is annex'd, a Difcourfe concerning Pilafters, and of feveral Abufes introduc'd into Architecture. Written in *French* by *Claude Perrault*, of the Royal Academy of *Paris*, and made *Englifh* by Mr. *John James* of *Greenwich*. The Second Edition.

2. An Analytick Treatife of Conic Sections, and their Ufe for refolving of Equations in Determinate and Indeterminate Problems. Being the Pofthumous Work of the Marquis *De l'Hofpital*, Honorary Fellow of the Academy Royal of Sciences. Made *Englifh* by *E. Stone.*

3. An Introduction to Natural Philofophy: or, Philofophical Lectures read in the Univerfity of *Oxford*, *Anno Dom.* 1700. To which are added, The Demonftrations of Monfieur *Huygens*'s Theorems, concerning the Centrifugal Force and Circular Motion. By *John Keil*, M. D. Savilian Profeffor of Aftronomy, F. R. S. Tranflated from the laft Edition of the *Latin*. The Third Edition.

4. The Philofophical Works of the Honourable *Robert Boyle* Efq; Abridged, Methodized, and Difpofed under the general Heads of Phyfics, Statics, Pneumatics, Natural Hiftory, Chymiftry, and Medicine: The whole illuftrated with Notes, containing the Improvements made in the feveral Parts of Natural and Experimental Knowledge fince his Time. In Three Volumes. By *Peter Shaw*, M. D. The Second Edition, corrected.

5. Chriſtophori Cellarii Smalcaldenſis Geographia Antiqua, recognita denuo, & ad veterum novorumque Scriptorum fidem, Hiſtoricum maxime, identidem caſtigata, & Quinta Editione plurimis Locis aucta & immutata. Huic demum Sextæ Editioni tot Chartas ex majori auctores Geographia Antiqua quot ad minorem hanc illuſtrandum requirebantur, duplicemque Indicem, quorum Priori Vetera locorum nomina Novis præponuntur, Poſteriori nova Veteribus. Addidit, totam recenſuit, & Scholarum uſui accommodavit, *Samuel Patrick.*

6. Univerſal Arithmetick: or a Treatiſe of Arithmetical Compoſition and Reſolution. To which is added, Dr. *Halley*'s Method of finding the Roots of Equations Arithmetically. Written in *Latin* by Sir *Iſaac Newton*, and tranſlated by the late Mr. *Ralphſon*, and Reviſed and Corrected by Mr. *Cunn.* The Second Edition very much Corrected.

Now in the Preſs, and ſpeedily will be publiſhed,

A New MATHEMATICAL DICTIONARY: Wherein is contained, not only the Explanation of the bare Terms, but likewiſe an Hiſtory of the Riſe, Progreſs, State, Properties, *&c.* of Things, both in pure Mathematicks and Natural Philoſophy, ſo far as it comes under a Mathematical Conſideration. By *E. Stone*, F. R. S. The Second Edition, with large Additions, 8vo.



2

EXPERIMENTS

AND

OBSERVATIONS

TENDING TO ILLUSTRATE THE

NATURE

AND

PROPERTIES

OF

ELECTRICITY.

In one LETTER to *Martin Folkes*, Esq; President, and Two to the *Royal Society*.

By *WILLIAM WATSON*, F.R.S.

LONDON:

Printed by JACOB ILIVE, for the AUTHOR

MDCC XLV.

TO

Martin Folkes, Esq;

P. R. S.

SIR,

THE Society having heard from some of their Correspondents in *Germany*, that what they call a Vegetable Quintessence, had been fired by Electricity, I take this Opportunity to acquaint you, that on *Friday* Evening last I succeeded, after having been disappointed in many Attempts, in setting Spirits of Wine on Fire by that Power. The preceding Part of the Week

had been remarkably warm, and the Air very dry, than which nothing is more neceſſary towards the Succeſs of Electrical Trials; to theſe I may add, that the Wind was then Eaſterly and inclining to freezing. I that Evening uſed a glaſs Sphere as well as a Tube; but I always find myſelf capable of ſending forth much more Fire from the Tube than from the Sphere, probably from not being ſufficiently uſed to the laſt. I had before obſerv'd, that although * non Electric Bodies made electrical, looſe almoſt all that Electricity by coming either within

* I call *Electrics per ſe* or originally *Electrics*, thoſe Bodies, in which an attractive Power towards light Subſtances is eaſily excited by Friction; ſuch as Glaſs, Amber, Sulphur, Sealing-wax, and moſt dry Parts of Animals, as Silk, Hair and ſuch like. I call *non Electrics* or Conductors of Electricity, thoſe Bodies, in which the above Property is not at all or very ſlightly perceptible; ſuch as Wood, Animals living or dead, Metals and vegetable Subſtances. See *Gray*, *Du Fay*, *Deſaguliers*, *Wheler*, in the Philoſophical Tranſactions.

in or near the Contact of *non Electrics* not made electrical; it happens otherwise with Regard to *Electrics per se*, when excited by rubbing, patting, &c; because from the rubbed Tube I can sometimes procure five or six Flashes from different Parts, as though the Tube of two Foot long, instead of being one continued Cylinder, consisted of five or six separate Segments of Cylinders, each of which gave out its Electricity at a different Explosion.

The Knowledge of this Theorem is of the utmost Consequence towards the Success of electrical Experiments; inasmuch as you must endeavour by all possible Means to collect the Whole of this Fire at the same Time. Professor *Hollman* seems to have endeavour'd at this and succeeded, by having a tin Tube, in one End of which he put a great many Threads, whose Extremities touch'd the Sphere when in Moti-

on

on, and each Thread collected a Quantity of electrical Fire, the Whole of which center'd in the tin Tube, and went off at the other Extremity. Another Thing to be obſerv'd, is to endeavour to make the Flaſhes follow each other ſo faſt, as that a Second may be viſible before the Firſt is extinguiſh'd. When you tranſmit the electrical Fire along a Sword or other Inſtrument, whoſe Point is ſharp, it often appears as a Number of diſſeminated Sparks, like wet Gunpowder or *Wildfire*; but if the Inſtrument has no Point, you generally perceive a pure bright Flame, like what is vulgarly call'd the *Blew-ball*, which gives the Appearance of Stars to fired Rockets.

The following is the Method I made uſe of and was happy enough to ſucceed in. I ſuſpended a Poker in ſilk Lines; at the Handle of which I hung ſeveral little Bundles of white

Thread,

Thread, the Extremities of which were about a Foot at right Angles from the Poker. Among theſe Threads, which were all attracted by the rubbed Tube, I excited the greateſt electrical Fire I was capable of, whilſt an Aſſiſtant near the End of the Poker held in his Hand a Spoon, in which were the warm Spirits; thus the Thread communicated the Electricity to the Poker, and the Spirit was fired at the other End. It muſt be obſerv'd in this Experiment, that the Spoon with the Spirit muſt not touch the Poker; if it does, the Electricity without any flaſhing is communicated to the Spoon, and to the Aſſiſtant in whoſe Hand it is held, and ſo is loſt in the Floor.

By theſe Means, I fired ſeveral Times not only the ætherial Liquor or Phlogiſton of *Frobenius* and rectified Spirit of Wine, but even common proof Spirit. Theſe Experiments, as

I before obſerv'd, were made laſt *Friday* Night, the Air being perfectly dry. *Sunday* proved wet and *Monday* pretty warm, ſo that the Air was full of Vapour; Wind South Weſt and cloudy. Under theſe Diſadvantages, on *Monday* Night I attempted again my Experiments; they ſucceeded, but with infinitely more Labour than the preceeding, becauſe of the Unfitneſs of the Evening for ſuch Trials. Your Candour will not permit you to think my Minuteneſs trivial, with Regard to the Circumſtances of the Weather, who know, how many Things muſt concur to make theſe Experiments ſucceed. I ſhall wait with Impatience for a proper Opportunity to have theſe Experiments repeated in your Preſence, and am with the utmoſt Reſpect,

Sir your moſt obedient,

Alderſgate-Street,
March 27. 1745.

humble Servant,

W. WATSON.

TO THE

ROYAL SOCIETY.

GENTLEMEN,

I LATELY acquainted you, that I had been able to fire Spirit of Wine, *Phlogiston* of *Frobenius*, and common proof Spirit, by the Power of Electricity. Since which (till Yesterday) we have had but one very dry fine Day; *viz. Monday, April* 15. Wind E. N. E; when about four o' Clock in the Afternoon I got my *Apparatus* ready, and fired the Spirit of Wine four Times from the Poker as before, three Times from the Finger of a Person electrified standing, upon

a Cake of Wax, and once from the Finger of a ſecond Perſon ſtanding upon Wax, communicating with the firſt by means of a walking Cane held between their Arms extended. The horizontal Diſtance in this Caſe between the glaſs Tube and the Spirit was at leaſt ten Feet.

You all know, that there is the repulſive Power of Electricity, as well as the attractive; inaſmuch as you are able, when a Feather or ſuch like light Subſtances are replete with Electricity, to drive them about a Room, which Way you pleaſe. This repulſive Power continues, untill either the Tube loſes its excited Force, or the the Feather attracts the Moiſtures from the Air, or comes near to ſome non electric Subſtance; if ſo, the Feather is attracted by and its Electricity loſt in whatever non Electric it comes near. In electrified Bodies, you ſee a perpetual Endeavour to get rid of their Electricity

lectricity. This induced me to make the following Experiment. I placed a Man upon a Cake of Wax, who held in one of his Hands a Spoon with the warm Spirits, and in the other a Poker with the Thread. I rubbed the Tube amongſt the Thread and electrified him as before. I then ordered a Perſon not electrified to bring his Finger near the Middle of the Spoon; upon which, the Flaſh from the Spoon and Spirit was violent enough to fire the Spirit. This Experiment I then repeated three Times. In this Method, the Perſon by whoſe Finger the Spirit of Wine is fired, feels the Stroke much more violent, than when the electrical Fire goes from him to the Spoon. This Method for the Sake of Diſtinction, we will call the repulſive Power of Electricity.

The late Dr. *Deſaguliers* has obſerved in his excellent Diſſertation concerning Electricity, " That there is a

" Sort of Capriciousness, attending
" these Experiments, or something un-
" accountable in their Phænomena
" not to be reduced to any Rule.
" For sometimes an Experiment,
" which has been made several Times
" successively, will all at once fail."
Now I imagine that the greatest Part, if not the Whole of this Matter depends upon the Moisture or Dryness of the Air, a sudden though slight Alteration in which, perhaps not sufficient to be obvious to our Faculties, may be perceived by the very subtle Fire of Electricity. For

1*st*, I CONCEIVE, that the Air itself (as has been observed by Dr. *Desaguliers)* is an *Electric per se* and of the vitreous Kind; therefore it repels the Electricity arising from the glass Tube and disposes it to electrify whatever non electrical Bodies receive the Effluvia from the Tube.

THAT

2dly, THAT Water is a *nonElectric* and of Consequence a Conductor of Electricity; this is exemplified by a Jett of Water being attracted by the Tube, from either *Electric*'s *per se* conducting Electricity, and *non Electric*'s more readily when wetted; but what is more to my present Purpose, is, that if you only blow through a dry glass Tube, the Moisture from your Breath will cause that Tube to be a Conductor of Electricity.

THESE being premised; in proportion as the Air is replete with watery Vapours, the Electricity arising from the Tube, instead of being conducted as proposed, is, by means of these Vapours, communicated to the circumambient Atmosphere and dissipated as fast as excited.

THIS Theory has been confirmed to me by divers Experiments, but by none more remarkably than on the Evening

vening of the Day I made thoſe before-mention'd; when the Vapours, which in the Afternoon by the Sun's Heat and a briſk Gale were diſſipated and the Air perfectly dry, deſcended again in great Plenty upon the Abſence of both, and the Evening was very damp. For between ſeven and eight o'Clock, I attempted again the ſame Experiments in the ſame Manner, without being able to make any of them ſucceed; though all thoſe mention'd in this Paper with others of leſs Note, were made in Half an Hour's Time.

I AM the more particular in this, being willing to ſave the Labour of thoſe, who are deſirous of making theſe Kind of Trials; for although ſome of the leſſer Experiments may ſucceed almoſt at any Time, yet I never could find that the more remark-

able

able ones would ſucceed but in dry Weather.

I am, Gentlemen,

London April 25, 1745.

Your moſt obedient,

humble Servant,

W. WATSON.



TO

TO THE

Royal Society.

Gentlemen,

IN ſome Papers I lately did myſelf the Honour to lay before you, I acquainted you of ſome Experiments in Electricity; particularly I took notice of having been able to fire Spirit of Wine by what I call'd the repulſive Power thereof, which I have not heard had been thought off by any of thoſe *German* Gentlemen, to whom the World is obliged for many ſurprizing Diſcoveries in this Part of natural Philoſophy.

How

How far ſtrictly ſpeaking the Spirit in this Operation may be ſaid to be fired by the repulſive Power of Electricity, or how far that Power, which repels light Subſtances when fully impregnated with Electricity, fires the Spirit, may probably be the Subject of a future Inquiry; but as I am unwilling to introduce more Terms into any Demonſtration than what are abſolutely neceſſary for the more ready Conception thereof, and as inflammable Subſtances may be fired by Electricity two different Ways, let the following Definitions at preſent ſuffice of each of theſe Methods.

BUT firſt give me Leave to premiſe, that no inflammable Subſtances will take fire, when brought into or near the Contact of *Electrics per ſe* excited to Electricity; this Effect muſt be produced by non electrical Subſtances impregnated with Electricity re-

ceived from the exciting *Electrics per se.* But to retun,

1*st*, I SUPPOSE that inflammable Subſtances are fired by the attractive Power of Electricity, when this Effect ariſes from their being brought near excited non Electrics.

2*dly*, THAT inflammable Subſtances are fired by the repulſive Power of Electricity; when it happens, that the inflammable Subſtances being firſt electrified themſelves, are fired by being brought near non Electrics not excited.

THIS Matter will be better illuſtrated by an Example; ſuppoſe that either a Man ſtanding upon a Cake of Wax, or a Sword ſuſpended in ſilk Lines are electrified, and the Spirit being brought near them, is fired, this is ſaid to be perform'd by the attractive Power of Electricity. But if the Man electrified as before holds a Spoon in his Hand containing the Spirit, or the

the ſame Spoon and Spirit are placed upon the Sword and a Perſon not electrified applies his Finger near the Spoon, and the Spirit is fired from the Flame ariſing from the Spoon and Spirit upon ſuch Application; this I call being fired by the repulſive Power. Of the two mention'd Kinds I generally find the repulſive Power ſtrongeſt.

Since my laſt Communication, the Spirit has been fired both by the attractive and repulſive Power through four Perſons ſtanding upon electrical Cakes; each communicating with the other either by the Means of a walking Cane, a Sword, or any other non electric Subſtance. It has likewiſe been fired from the Handle of a Sword held in the Hand of a third Perſon.

I have not only fired *Frobenius*'s Phlogiſton, rectified Spirit and common proof Spirit, but alſo ſal volatile Oleoſum, Spirit of Lavender, dulcified

Spirit of Nitre, Peony Water, *Daffy*'s Elixir, *Helvetius*'s Stiptick, and ſome other Mixtures where the Spirit has been very conſiderably diluted; likewiſe diſtilled vegetable Oils, ſuch as that of Turpentine, Lemon, Orange Peels and Juniper, and even thoſe of them, which are ſpecifically heavier than Water, as Oil of Saſſafras; alſo reſinous Subſtances, ſuch as Balſam Capivi and Turpentine; all which ſend forth when warmed an inflammable Vapour. But expreſſed vegetable Oils, as thoſe of Olives, Linſeed and Almonds, as well as Tallow, all whoſe Vapours are uninflammable, I have not been able yet to fire; but theſe indeed will not fire on the Application of lighted Paper. Beſides, if theſe laſt would fire with lighted Paper, unleſs their Vapours were inflammable, I can ſcarce conceive they would fire by Electricity; becauſe in firing Spirits, *&c.* I always perceive that the

lectricity

Electricity ſnaps before it comes in Contact with their Surfaces, and therefore only fires their inflammable Vapours.

As an excited non Electric emits almoſt all its Fire, if once touch'd by a non Electric not excited. I was deſirous of being ſatisfy'd, whether or no the Fire emitted would not be greater or leſs in proportion to the Volume of the electrified Body. In order to this I procur'd an Iron Bar about five Feet long and near 170 Pounds in Weight; this I electrified lying on Cakes of Wax and Roſin, but obſerv'd the Flaſhes ariſing therefrom not more violent than thoſe from a common Poker. In making this Experiment, being willing to try the repulſive Force, it once happen'd that whilſt the Bar was at one End electrifying, a Spoon lay upon the other, and upon an Aſſiſtant's pouring ſome warm Spirit into the Spoon, the electrical

trical Flaſh from the Spoon ſnapped and fired the firſt Drop of the Spirit, which unexpectedly fired not only the whole Jett as it was pouring, but kindled likewiſe the whole Quantity in the Pot, in which I uſually have it warm'd.

I FIND that in firing inflammable Subſtances from the Finger of a Man ſtanding upon Wax, that *cæteris paribus* the Succeſs is more conſtant, if the Man inſtead of holding the Thread (the Uſe of which I communicated in a former Paper) in his Hand, the Thread is ſuſpended at the End of an Iron Rod held in one Hand, and he touches the Spirit with one of the Fingers of the other.

IF a Man ſtanding upon the electrical Cake with a Diſh or deep Plate of Water in one Hand, and the Iron Rod with the Thread in the other, is made electrical; and a Perſon not electrified touches any Part either of the

Plate

Plate or Water, the Flashes of Fire come out plentifully, and wherever you bring your Finger very near, the Water rises up in a little Cone, from the Point of which the Fire is produced, and your Finger though not in actual Contact is made wet. The same Experiment succeeds through three or more People.

IN firing inflammable Substances, the Person who holds the Spoon in his Hand to receive the electrical Flashes, when the Finger of the electrified Person is brought near thereto, not only feels a tingling in his Hand, but even a slight Pain up to his Elbow. This is most perceptibly in dry Weather, when the Electricity is very powerful.

THERE is a considerable Difficulty in firing *Electrics per se*, such as Turpentine, and Balsam Capivi by the repulsive Power of Electricity; because in this Case these Substances will not

permit the Electricity to paſs through them, therefore when you would have this Experiment ſucceed, the Finger of the Perſon who is to fire them is to be applied as near to the Edge as poſſible of theſe Subſtances when warm'd in a Spoon, that the Flaſhes from the Spoon (for theſe Subſtances will emit none) may ſnap, where they are ſpread the thinneſt and then fire their Effluvia. This Experiment, as well as ſeveral others, ſerves to confute that Opinion which has prevail'd with many, that the Electricity floats only upon the Surfaces of Bodies.

If an electrical Cake is dipp'd in Water, it is thereby made a Conductor of Electricity, the Water hanging about it tranſmitting the electrical Effluvia in ſuch a manner, that a Perſon ſtanding thereon can by no means be electrified enough to attract the leaf Gold at the ſmalleſt Diſtance; though the Perſon ſtanding upon the ſame

Cake when dry, attracted a Piece of fine Thread hanging at the Diftance of two Feet from his Finger. We muft here obferve that the Cake being of an unctuous Subftance, the Water will no where lie uniformly thereon, but adhere in feparate Moleculæ; fo that in this Inftance the Electricity jumps from one Particle of Water to another till the Whole is diffipated.

FROM the Appearance of the Threads amongft which I rub the Tube, I can frequently judge though the Spirit may be many Feet diftant from them, whether or no, it will fire, becaufe when the Perfons ftanding upon the Wax are made electrical enough to fire the Spirit, the Threads repel each other at their lower Parts where they are not confin'd, to a confiderable Diftance, and this Diftance is in Proportion as the Threads are made electrical.

If two Perſons ſtand upon electrical Cakes at about a Yard's Diſtance from each other, one of which for the Sake of Diſtinction, we will call A, the other B. If A when electrified touches B, A looſes almoſt all his Electricity at that Touch only, which is receiv'd by B and ſtopp'd by the electrical Cake; if A is immediately electrified again to the ſame Degree as before and touches B the Snapping is leſs upon the Touch; and this Snapping upon electrifying A grows leſs and leſs, till B being impregnated with Electricity though receiv'd at Intervals, the Snapping will no longer be ſenſible.

That Glaſs will repel and not conduct the Electricity of Glaſs, has been mention'd by others, who have treated of this Subject; but the Experiments to determine this Matter muſt be conducted with a great deal of Caution; for unleſs the glaſs Tube, intended to conduct the Electricity, be as warm as the

the External Air, it will ſeem to prove the contrary, unleſs in very dry Places and Seaſons. Thus I ſometimes have brought a cold, though dry Glaſs Tube near three Feet long into a Room, where there has been a Number of People, when upon placing the Tube upon Silk Lines and laying ſome Leaf Silver upon a Card at one End and rubbing another Glaſs Tube at the other, the Silver has, contrary to Expectation, been thrown off as readily as from an Iron Rod. At firſt I was ſurpriz'd at this Appearance, but then conjectur'd, that it muſt ariſe from the Coldneſs of the Glaſs, condenſing the floating Vapour of the Room; in Order then to obviate this, I warm'd the Tube ſufficiently, and this Effect was no longer produced, but the Silver lay perfectly ſtill.

SOME few Years ago, Sir *James Lowther* brought ſome Bladders fill'd with inflammable Air, collected from

his Coal-mines, to the Royal Society. This Air flam'd upon a lighted Candle being brought near it. This Inflammability has occaſion'd many terrible Accidents. Mr. *Maud*, a worthy Member of this Society, made at that Time by Art and ſhew'd the Society, Air exactly of the ſame Quality. I was deſirous of knowing if this Air would be kindled by electrical Flaſhes. I accordingly made ſuch Air by putting an Ounce of Filings of Iron, an Ounce of Oil of Vitriol and four Ounces of Water into a Florence Flaſk; upon which an Ebullition enſued and the Air which aroſe from theſe Materials, not only fill'd three Bladders, but alſo upon the Application of the Finger of an Electrified Perſon took Flame and burnt near the Top and out of the Neck of the Flaſk a conſiderable Time. When the Flame is almoſt out, ſhake the Flaſk and the Flame revives. You

muſt

muſt with your Finger dipped in Water, moiſten the Mouth of the Flaſk as faſt as it is dried by the Heat within; or the Electricity will not fire it: Becauſe the Flaſk being an Electric *per ſe* will not ſnap at the Application of the Finger, without the Glaſs being firſt made non-electric by wetting. It has ſometimes happen'd, that if the Finger has been applied, before the inflammable Air has found a ready Exit from the Mouth of the Flaſk, that the Flaſh has fill'd the Flaſk and gone off with an Exploſion equal to the firing of a large Piſtol, and ſometimes indeed it has burſt the Flaſk. The ſame Effect is produced from the Spirit of Sea Salt, as from Oil of Vitriol; but as the Acid of Sea Salt is much lighter than that of Vitriol, there is no Neceſſity to add the Water in this Experiment.

Those who are not much acquainted with Chemical Philoſophy, may think

think it very extraordinary, that from a Mixture of cold Subſtances, which both conjunctly and ſeparately are uninflammable, this very inflammable Vapour ſhould be produced. In Order to ſolve this, it may not be improper to premiſe, that Iron is compounded of a Metallic as well as a Sulphureous Part. This Sulphur is ſo fix'd, that after heating the Iron red hot, and even melting it ever ſo often, the Sulphur will not be diſengaged therefrom: But upon the Mixture of the Vitriolic Acid, and by the Heat and Ebullition which are almoſt inſtantly produced, the Metallic Part is diſſolved and the Sulphur which before was intimately connected therewith, being diſengaged, becomes Volatile. This Heat and Ebullition continues 'till the Vitriolic Acid is perfectly ſaturated with the Metallic Part of the Iron, and the Vapour once fired continues to flame, until this Saturation being

being affected, no more of the Sulphur flies off.

I HAVE heretofore mentioned how considerably, perfectly dry Air conduces to the Succefs of thefe Experiments; but we have been lately informed by an Extract of a Letter, that *Abbé Nolet* was of Opinion that they would fucceed in wet Weather, provided the Tubes were made of Glafs, tinged blue with Zaffer. I have procured Tubes of this Sort, but after giving them many candid Trials, I cannot think them equal to their Recommendation. I firft tried one of them in a fmart Shower of Rain after a dry Day, when the Drops were large, and the Spirit fired three Times in about four Minutes, the fame Effect fucceeded under the fame Circumftances from the White one; but after three or four Hours raining, when the Air was perfectly wet, I never could make it fucceed. And to il-

illuſtrate this Matter further, I have been able when the Weather has been very dry, with once rubbing my Hand down this Blue Tube and applying it to the End of an Iron Rod ſix Feet long, to throw off ſeveral Pieces of Leaf Silver lying upon a Card at the other End of this Rod, whereas I never have been able to throw it off by any Means in very wet Weather. Beſides I am of Opinion, that after the Electrical Fire is gone from the Tube, the Tube has no Share in the conducting of it; my Sentiments on that Head I laid before you in a former Paper: For if the Silk Lines are wetted they diffuſe all the Electricity, and the ſame Effects happen when the Air is wet, be your Glaſs of what Colour it will. It may not be improper here to obſerve, that Zaffer, which is uſed by the Glaſs-makers and Enamellers, is made of Cobalt or Mundick calcin'd after the ſubliming the

Flowers.

Flowers. This being reduced to a very fine Powder, and mixt with twice or thrice its own Weight of finely powdered Flints, is moiſten'd with Water and put up in Barrels, in which it ſoon runs into a hard Maſs and is call'd Zaffer.

A DRY Sponge hanging by a Packthread at the End of an electrified Sword, or from the Hand of an electrified Man, gives no Signs of being made Electrical; if it is well ſoak'd in Water, wherever it is touched you both ſee and feel the Electrical Sparks. Not only ſo, but if it is ſo full of Water, that it falls from the Sponge, thoſe Drops in a dark Room, receiv'd upon your Hand, not only flaſh and ſnap, but you perceive a pricking Pain. If you hold your Hand or any non Electrical Subſtances very near, the Water which had ceaſed dropping when the Sponge was not electrified, drops again upon its being

electrified, and the Drops fall in Proportion to the receiv'd Electricity, as though the Sponge were gently ſqueez'd between your Fingers. I was deſirous to know if I was able to electrify a Drop of cold Water, dropping from the Sponge, enough to fire the Spirit; but after many unſucceſsful Trials, I was forced to deſiſt, becauſe the cold Water dropping from the Sponge not only cool'd the Spirit too much, but alſo render'd it too weak; likewiſe every Drop carried with it, great Part of the Electricity from the Sponge. I then conſider'd in what Manner, I could give a Tenacity to the Water, ſufficient to make the Drops hang a conſiderable Time, and this I brought about by making a Mucilage of the Seeds of Fleawort. A wet Sponge then, ſqueez'd hard and fill'd with this cold Mucilage was held in the Hand of an electrified Man, when the Drops

forced

forced out by the Electricity, assisted by the Tenacity of the Liquor, hung some Inches from the Sponge, and by a Drop of this I fir'd not only the Spirit of Wine, but likewise the inflammable Air before mentioned both with and without the Explosion. What an extraordinary Effect is this! That a Drop of cold Water (for the Seeds contribute nothing, but add Consistence to the Water) should be the Medium of Fire and Flame.

CAMPHOR is a vegetable Resin and of Consequence an Electric *per se*. This Substance notwithstanding its great Inflammability, will not take fire from the Finger of a Man or any other Body electrified, though made very warm and the Vapours arise therefrom in great Abundance. Because neither Electric's *per se* excited, or electrified Bodies, exert their Force upon Electric's *per se*, though not excited. If you break Camphor small

and warm it in a Spoon, it is not melted by Heat like other Refins, but if that Heat were continued it would all prove Volatile. To Camphor thus warm'd, the Finger of an electrified Man, a Sword or fuch like, will in Snapping exert its Force upon the Spoon, and the Circumambient Vapour of the Camphor will be fired thereby, and light up the whole Quantity expofed. The fame Experiment fucceeds by the repulfive Power of Electricity.

A Poker thoroughly ignited put into Spirit of Wine, or into the diftilled Oil of Vegetables, produces no Flame in either; it indeed occafions the Vapours to arife from the Oil in great Abundance. But if you electrify this heated Poker, the electrical Flafhes prefently kindle Flame in either. The Experiment is the fame with Camphor. Thefe Experiments as well as the following fufficiently evince

vince that the electrical Fire is truly Flame, and that extreamly ſubtil.

I HAVE made ſeveral Trials in Order to fire Gunpowder alone, which I tried both warm and cold, whole and powder'd, but never could make it ſucceed; and this ariſes in part from its Vapours not being inflammable, and in part from its not being capable of being fir'd by Flame, unleſs the Sulphur in the Compoſition is nearly in the State of Accenſion. This we ſee by putting Gunpowder into a Spoon with rectified Spirit, which when lighted, will not fire the Powder, 'till by the Heat of the Spoon from the burning Spirit, the Sulphur is almoſt melted. Likewiſe, if you hold Gunpowder ground very fine in a Spoon over a lighted Candle, or any other Flame, as ſoon as the Spoon is hot enough to melt the Sulphur, you ſee a blue Flame and inſtantly the Powder flaſhes off. The ſame

Effects are obſerv'd in the *Pulvis fulminans*, compos'd of Nitre, Sulphur, and fixed Alkaline Salt. Beſides when the Gunpowder is very dry and ground very fine, it (as you pleaſe to make the Experiment) is either attracted, or repell'd; ſo that in the firſt Caſe, the End of your Finger when electrified ſhall be cover'd over with the Powder, though held at ſome Diſtance; and in the other, if you electrify the Powder, it will fly off at the Approach of any non electrified Subſtance and ſometimes even without it. But I can at Pleaſure fire Gunpowder and even diſcharge a Muſket by the Power of Electricity, when the Gunpowder has been ground with a little Camphor or with a few Drops of ſome inflammable chemical Oil; this Oil ſomewhat moiſtens the Powder and prevents its flying away; the Gunpowder then being warm'd in a Spoon, the electrical Flaſhes fire the inflammable Vapour,

which

which fires the Gunpowder: But the Time between the Vapour firing the Powder is ſo ſhort, that frequently they appear as the ſame and not ſucceſſive Operations, wherein the Gunpowder itſelf ſeems fired by the Electricity; and indeed the firſt Time this Experiment ſucceeded, the Flaſh was ſo ſudden and unexpected, that the Hand of my Aſſiſtant, who touch'd the Spoon with his Finger, was conſiderably ſcorch'd. So that there ſeems a fourth Ingredient neceſſary to make Gunpowder readily take Fire by Flame, and that ſuch a one, as will heighten the Inflammability of the Sulphur. In common Caſes the lighted Match or the little Portion of red hot Glaſs, which falls among the Powder and is the Reſult of the Colliſion from the Flint and Steel, fires the Charcoal and Sulphur, and theſe the Nitre. But if to theſe three Ingredients you add a fourth, *viz.* a Vegetable

getable chemical Oil, and gently warm this Mixture, the Oil by the Warmth mixes intimately with the Sulphur, lowers its Consistence, and makes it readily take fire by Flame. In these Operations notwithstanding I always made use of the finest scented Oils of Orange Peel, Lemons and such like, yet upon the least warming the Mixture, the rank Smell of Balsam (*i. e.* the ready Solution) of Sulphur was very obvious.

Read before the R. S.
Oct. 24. 1745.

A Continuation of the above.

Read, *Feb.* 6. 1745.

AS Water is a non Electric and of Consequence a Conductor of Electricity, I had Reason to believe that Ice was endowed with the same Properties. Upon making the Experiment,

periment I found my Conjectures not without Foundation, for upon electrifying a Piece of Ice, wherever the Ice was touched by a non Electric, it flashed and snapped. A Piece of Ice also held in the Hand of an electrified Man as the beforementioned Processes, fired warm Spirit, chemical vegetable Oils, Camphor, and Gunpowder prepared as before. But here great Care must be taken that by the Warmth of the Hand, or of the Air in the Room, the Ice does not melt; if so, every Drop of Water therefrom considerably diminishes the received Electricity. In Order to obviate this, I caused my Assistant, while he was electrifying, to be continually whiping the Ice dry upon a Napkin hung to the Buttons of his Coat, and this being electrified as well as the Ice, prevented any Loss of the Force of the Electricity. The Experiment will succeed likewise, if instead of the Ice, you electrify the Spi-

rit, *&c.* and bring the Ice not electrified near them. I muſt obſerve, that Ice is not ſo ready a Conductor of Electricity as Water; ſo that I very frequently have been diſappointed in endeavouring with it to fire inflamable Subſtances, when it has been readily done by a Sword or the Finger of a Man.

In the firſt Paper * I had the Honour to lay before you upon this Subject, I took Notice of my having obſerved two different Appearances of the Fire from electrified Subſtances; *viz.* thoſe large bright Flaſhes, which may be procured from any Part of electrified Bodies, by bringing a non Electric unexcited near them, and with which we have fired all the inflammable Subſtances mentioned in the Courſe of theſe Obſervations; and thoſe, like the firing of wet Gunpowder, which are only perceptible at the Points or Edges

* Page 6.

Edges of excited non Electrics. These last also appear different in Colour and Form according to the Substances from which they proceed: For from polished Bodies, as the Point of a Sword, a Silver Probe, the Points of Sciffars, and the Edges of the Steel-bar made Magnetical by the ingenious Dr. *Knight*, the electrical Fire appears like a Pencil of Rays, agreeing in Colour with the Fire from *Boyle*'s Phosphorus; but from unpolished Bodies, as the End of a Poker, a rusty Nail or such like, the Rays are much more red. The Difference of Colour here, I am of Opinion, is owing rather to the different Reflection of the electrical Fire from the Surface of the Body from which it is emitted, than to any Difference in the Fire itself. These Pencils of Rays issue successively as long as the Bodies from which they proceed are exciting; but they are longer and more brilliant, if you bring

any non Electric not excited near them, though it muſt not be cloſe enough to make them ſnap. If you hold your Hand at about two or three Inches Diſtance from theſe Points, you not only feel ſucceſſive Blaſts of Wind from them, but hear alſo a crackling Noiſe. Where there are ſeveral Points, you obſerve at the ſame Time ſeveral Pencils of Rays.

It appears from Experiments, that beſides the ſeveral Properties, that Electricity is poſſeſs'd of peculiar to itſelf, it has ſome, in common with Magnetiſm and Light.

Proposition I.

In common with Magnetiſm, Electricity counteracts and in light Subſtances overcomes the Force of Gravity. Like that extraordinary Power likewiſe, it exerts its Force *in Vacuo* as powerfully as in open Air, and this

Force

Force is extended to a considerable Distance through various Substances of different Textures and Densities.

COROLLARY.

GRAVITY is the general Endeavour and Tendency of Bodies towards the Center of the Earth; this is overcome by the Magnet with Regard to Iron, and by Electricity with Regard to light Substances both in its Attraction and Repulsion; but I have never been able to discern that vortical Motion, by which this Effect was said to be brought about by the late Dr. *Desaguliers* and others, having no other Conception of its Manner of acting than as Rays from a Center, which indeed is confirmed by several Experiments. Some have imagined a Polarity also, when they have observed one End of an excited Glass Tube repel light Substances and the other attract them.

them. But this is a Deception, arising from the whole Length of the Tube not being excited, but only such Part of it as has been rubbed; so that as much of the Tube as is held in the Hand, remains in an unexcited State and permits light Substances to lie still thereon, though forcibly repell'd at the other End. This attractive Power of Electricity acts not only upon non Electrics, as Leaf Gold, Silver, Thread, and such like, but also upon originally Electrics, as Silk, dry Feathers, little Pieces of Glass and Resin; it attracts all Bodies, that are not of the same Standard of Electricity, (if I may be allowed the Expression) as the excited Body from which it proceeds. I have found no Body however dense, whose Pores are not pervious to Electricity by a proper Management, not even Gold itself.

Proposition II.

In common with Light, Electricity pervades Glaſs, but ſuffers no Refraction therefrom; I having from the moſt exact Obſervations found its Direction to be in right Lines, and that through Glaſſes of different Forms, included one within the other and large Spaces left between each Glaſs.

Corollary.

This rectilinear Direction is obſervable only as far as the Electricity can penetrate through unexcited originally Electrics and thoſe perfectly dry; nor is it all material, whether theſe Subſtances are tranſparent, as Glaſs; ſemidiaphanous, as Porcelain or thin Cakes of white Wax; or quite opake, as thick woollen Cloth as well as woven Silk of various Colours; it is only neceſ-

neceſſary that they are originally Electrics. But the Caſe is widely different with Regard to non Electrics; wherein the Direction, given to the Electricity by the excited originally Electric, is alter'd as ſoon as it touches the Surface of a non Electric, and is propagated with a Degree of Swiftneſs ſcarcely to be meaſured in all poſſible Directions to impregnate the whole non Electric Maſs in Contact with it or nearly ſo, however different in itſelf, and which muſt of neceſſity be terminated by an originally Electric, before the Electricity exerts the leaſt Attraction, and then this Power is obſerved firſt at that Part of the non Electric the moſt remote for the originally Electric. Thus for Example, by an excited Tube held over it, Leaf Gold will be attracted through Glaſs, Cloth, *&c.* held horizontally in the Hand of a Man ſtanding upon the Floor and this Attraction

traction is exerted to a considerable Distance. On the contrary, the rubbed Tube will not attract Leaf Gold or other light Bodies however near through Silver, Tin, the thinnest Board, Paper, or any other non Electric, held in the Manner before mentioned. But if you rub the Paper over with Wax melted, and by that Means introduce the originally Electric therein, you observe the Electricity acts in right Lines and attracts powerfully. And here I must beg leave to remind you, not only of the former Corollary, but of some of the former Experiments also; by which it appears, that although to make a non Electric exert any Power, we must excite the whole Mass thereof, yet we can excite what Part and what only of an originally Electric we please. Thus we observe, that Leaf Gold and the Seed of Cotton-grass, which grows upon Boggs and is a very proper Subject for these In-

quiries, are attracted under a Glaſs Jar, turned Bottom upwards, upon which are placed Books and ſeveral other non Electrics, and that the Motions of the light Bodies underneath correſpond with the Motions of the Glaſs Tube held over them, the Electricity ſeeming inſtantaneouſly to paſs through the Books and the Glaſs. But this does not happen, till the Electricity has fully impregnated the non Electrics which lie upon the Glaſs, which received Electricity is ſtopped by the Glaſs, and then theſe non Electrics, dart their Power directly through the upper Part of the Glaſs after the Manner of originally Electrics. But if the thinneſt non Electric, even the fineſt Paper, as I before mentioned, is held in the Hand of a Man at the ſmalleſt Diſtance over the Leaf Gold and the Electricity is not ſtopped, not the leaſt Power will be exerted and the Gold will lie ſtill. I muſt here remark like-

likewiſe, that this Law of Electricity is ſo conſtant and regular, that I have not found one Deviation from it; ſo that even the Quickſilver, ſpread thin as it uſually is at the Back of a Plate of a Looking-glaſs, will prevent the paſſing through of the electrical Attraction, unleſs ſtopped by an originally Electric. This Penetration of the electrical Power through originally Electrics is much greater than has hitherto been imagined, and has cauſed the Want of Succeſs to great Numbers of Experiments. I have been at no ſmall Pains to determine, how far this Power can penetrate through a dry originally Electric; and have found by repeated Trials, that either in a Cake of Wax alone or of Wax and Reſin mixed, when the Electricity is very powerful, it has paſſed, I ſay, in ſtraight Lines through theſe Cakes of the Thickneſs of 2 Inches and $\frac{4}{10}$; but I never could make it act through one

of 2 Inches $\frac{8}{10}$, for in this it was perfectly ſtopped. So that the Cakes commonly made uſe of to ſtop the Electricity, by being too thin ſuffer a conſiderable Quantity of the electrical Power to pervade them, and be loſt in the Floor. I make no Doubt, if the electrical Power could be more increaſed, it would penetrate much further through theſe originally Electric Bodies.

PROPOSITION III.

ELECTRICITY in common with Light likewiſe, when its Forces are collected and a proper Direction given thereto upon a proper Object, produces Fire and Flame.

COROLLARY.

THE Fire of Electricity (as I have before obſerved) is extremely delicate and

and ſets on Fire, as far as I have yet experienced, only inflammable Vapours. Nor is this Flame at all heightned by being ſuperinduced upon an Iron Rod, red hot with coarſer culinary Fire as in a preceeding Experiment, nor diminiſhed by being directed upon cold Water. However I was deſirous of knowing, if this Flame would be affected by a ſtill greater Degree of Cold; and in Order to determine this, I made an artificial Cold, by which the Mercury, in a very nice Thermometer adjuſted to *Fahrenheit*'s Scale, was depreſſed in about 4 Minutes from 15 Degrees above the freezing Point to 30 Degrees below it, that is, the Mercury fell 45 Degrees. From this cold Mixture when electrified, the Flaſhes were as powerful and the Stroke as ſmart as from the red hot Iron. I could have made the Cold more intenſe, but the above was ſufficient for my Purpoſe. This Experi-

ment

ment ſeems to indicate, that the Fire of Electricity is affected neither by the Preſence or Abſence of other Fire. For as red hot Iron, by Sir *Iſaac Newton*'s Scale of Heat, is fixed at 192 Degrees, and as the Ratio between Sir *Iſaac*'s Degrees and *Fahrenheit*'s is as 34 to 180, it neceſſarily follows, that the Difference of Heat between the hot Iron and the cold Mixture is 1040 Degrees, and nevertheleſs this vaſt Difference makes no Alteration in the Appearance of the electrical Flame.

I MAY perhaps be thought too minute in ſome of the before mentioned Particulars; but in Inquiries abſtruſe as theſe are, where we have ſo little *a priori* to direct us, the greateſt Attention muſt be had to every Circumſtance, if we are truly deſirous of inveſtigating the Laws of this ſurprizing Power. For as has been ſaid upon another Occaſion by my ever honoured

Friend

Friend MARTIN FOLKES, Esq; our most worthy President, "that Electricity seems to furnish an inexhaustible Fund for Inquiry, and sure Phœnomena so various and so wonderful can arise only from Causes very general and extensive, and such as must have been designed by the Almighty Author of Nature, for the Production of very great Effects, and such as are of great Moment to the System of the Universe."

IF these Observations receive the Countenance of this learned Society, I shall think myself sufficiently recompensed, and am,

Gentlemen, with the highest Esteem,

your most Obedient

humble Servant,

W. WATSON.

ERRATUM.

P. 4. L. 6. for *freezing*, read *Freeze*.

3

EXPERIMENTS

AND

OBSERVATIONS

TENDING TO ILLUSTRATE THE

NATURE

AND

PROPERTIES

OF

ELECTRICITY.

In one LETTER to *Martin Folkes*, Esq; President, and Two to the *Royal Society*.

By *WILLIAM WATSON*, F.R.S.

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THE

PREFACE.

THE following Sheets were not intended to be made publick, but as part of the *Philosophical Transactions*. As those Works are printed in the order of Time they are read; these Observations, communicated to the ROYAL SOCIETY at different Meetings, would, upon that Account, have been publish'd separate in different Numbers of those Transactions. To satisfy therefore the Impatience of several learned and very valuable Friends, to whose Importunities I have neither Will, nor Inclination to deny any thing in my Power to grant, I caused a few Copies to be print-

ed, that the whole might be ſeen together, and then broke up the Preſs. This has excited the Curioſity of the Publick, and raiſed a Demand for theſe Experiments much beyond what I had reaſon to expect. I therefore found it neceſſary to ſend them to the Preſs a ſecond Time, leſt ſome of thoſe over-officious Gentlemen, who are always ready on theſe Occaſions, ſhould do it for me; ſo that whoever has an Inclination, may now be made acquainted, by what Means the ſeveral ſurprizing Phænomena of Electricity have been brought about.

I choſe to lay theſe Papers before the Publick in the ſame Dreſs wherein they appeared before the very honourable and learned Body, to whom, as the various Effects of Electricity preſented themſelves, they were regularly communicated, and from whom they met with a very favourable Reception. Many Members of the ROYAL SOCIETY, *as well as ſeveral other Perſons of great*

Rank

Rank and Quality, have been repeated Witnesses of the Facts which are here laid before the World; particularly the present worthy President, MARTIN FOLKES, Esq; *whose extensive Abilities and great Knowledge in every Branch of useful Literature are exceeded only by his Candour and Zeal in promoting Science. The Advice and Assistance of this Gentleman, whose Friendship I shall always esteem as one of the greatest Happinesses of my Life, has been of great Moment in the Prosecution of these Discoveries. I therefore take this publick Manner of testifying my sincerest Obligations as well to him, as to Sir* HANS SLOANE, Bart. *who, although retired from Business, is nevertheless attentive to whatever tends to the Advancement of Philosophy. Upon a Report made to him of these Experiments and Observations, he, as surviving Executor of Sir* GODFREY COPLEY, *was pleased to appoint me last Year to receive the annual*

nual Prize-medal of Gold, given by the ROYAL SOCIETY *in consequence of Sir* GODFREY'S *Benefaction. The Honour of being so particularly taken notice of by Gentlemen of such distinguished Merit, as it cannot but give me the highest Pleasure, so shall it ever continue to raise in me Sentiments of the truest Gratitude, and most profound Respect.*

IF it should be asked, to what useful Purposes the Effects of Electricity can be applied, it may be answered, that we are not as yet so far advanced in these Discoveries as to render them conducive to the Service of Mankind. Perfection in any Branch of Philosophy is to be attained but by slow Gradations. It is our Duty to be still going forward; the rest we must leave to the Direction of that Providence, which we know assuredly, has created nothing in vain. But I make no Scruple to assert, that notwithstanding the great Advances, which have been made in this

part

part of natural Philoſophy within theſe few Years, many and great Properties remain ſtill undiſcover'd. Future Philoſophers (ſome perhaps even of the preſent Age) may deduce from electrical Experiments, Uſes extremely beneficial to Society in general.

NO preſent Advantage accrued to thoſe Perſons, or to that Age, which firſt diſcover'd the Properties of the Magnet. Many hundreds of Years intervened, before they were applied to the great Uſes of Navigation. Had theſe remain'd a ſecret till now, what other Methods could have been ſubſtituted in their Place, by which we could ſecurely traverſe the vaſt Ocean? All the Advantages we receive from diſtant Commerce, we muſt ſtill have been Strangers to, but for this fortunate Application of the magnetical Power. And even the Diſcoveries thus far had been very imperfect, without the Knowledge of the Variation of the Compaſs. But the preſent

*ſent Age, and even this Nation, boaſts of a Gentleman**, *who ſeems to be entruſted with the magnetical Powers themſelves. He makes artificial Magnets, increaſes in a few Minutes the Powers of real ones to a ſurprizing Degree, changes at Pleaſure their Poles, and makes that newly acquired Polarity, permanent. The World, I hope, will not long be deprived of the Manner, by which theſe extraordinary Changes are produced, which as yet this Gentleman thinks proper to conceal. As Electricity has ſome Properties in common with Magnetiſm, as will be ſhewn in the Courſe of theſe Obſervations; ſome new Lights probably may be thrown upon both. But to return; admitting even, that no ſubſtantial Advantages could ariſe from the Inquiries before us, (which, however, we can by no means grant, upon our conſidering the Effects we already perceive of its Operations upon human Bodies) whatever*

* Dr. *Gowin Knight*, F. R. S.

tends

tends to enlarge the Conceptions of the Mind, and to implant in us ſtill more lofty Ideas of the Almighty Author of Nature, deſerves certainly, independent of other Conſiderations, our higheſt Regard.

THESE Experiments were all made with Glaſs Tubes of about two Foot long; the bore about an Inch in Diameter. But a ſcrupulous Exactneſs in theſe Proportions is no ways neceſſary. The thinner and lighter theſe Tubes are, the ſooner they are excited; though they, 'tis true, don't retain their Power ſo long as thoſe, which are more thick and ſubſtantial. But where you intend to communicate the electrical Power, as faſt as you excite it, I ſhould prefer a light Tube; though it ought never to be leſs than $\frac{1}{12}$ of an Inch thick, becauſe of the Danger of breaking it by the Friction.

THE Tube, before it is rubbed, ſhould be always made dry and warm, which may be done by laying it before

the Fire. But I cannot omit hereupon making one further Remark; viz. *that Glaſs Tubes, exactly of the ſame Dimenſions, made at the ſame Time, and with the ſame Materials, vary conſiderably with regard to their fitneſs for electrical Purpoſes. Clear and dry Air with ſome degree of cold is moſt eligible, though I have ſucceeded in the greateſt Fogs, but with more Difficulty.*

TO

Martin Folkes, Esq;

P. R. S.

SIR,

THE Society having heard from some of their Correspondents in *Germany*, that what they call a Vegetable Quintessence had been fired by Electricity, I take this Opportunity to acquaint you, that on *Friday* Evening last I succeeded, after having been disappointed in many Attempts, in setting Spirits of Wine on Fire by that Power. The preceding Part of the Week

 had

had been remarkably warm, and the Air very dry, than which nothing is more neceſſary towards the Succeſs of Electrical Trials; to theſe I may add, that the Wind was then Eaſterly and inclining to freeze. I that Evening uſed a glaſs Sphere as well as a Tube; but I always find myſelf capable of ſending forth much more Fire from the Tube than from the Sphere, probably from not being ſufficiently uſed to the laſt.

I HAD before obſerv'd, that although * Non-electric Bodies made electrical, loſe almoſt all that Electricity by coming either within or

* I call *Electrics per ſe* or originally-*electrics*, thoſe Bodies, in which an attractive Power towards light Subſtances is eaſily excited by Friction; ſuch as Glaſs, Amber, Sulphur, Sealing-wax, and moſt dry Parts of Animals, as Silk, Hair, and ſuch like. I call *Non-electrics* or Conductors of Electricity, thoſe Bodies, in which the above Property is not at all or very ſlightly perceptible; ſuch as Wood, Animals living or dead, Metals and vegetable Subſtances. See *Gray*, *Du Fay*, *Deſaguliers*, *Wheler*, in the Philoſophical Tranſactions.

or near the Contract of *Non-electrics* not made electrical; it happens otherwise with Regard to *Electrics per se*, when excited by rubbing, patting, &c; because from the rubbed Tube I can sometimes procure five or six Flashes from different Parts, as though the Tube of two Foot long, instead of being one continued Cylinder, consisted of five or six separate Segments of Cylinders, each of which gave out its Electricity at a different Explosion.

The Knowledge of this Theorem is of the utmost Consequence towards the Success of electrical Experiments; inasmuch as you must endeavour by all possible Means to collect the Whole of this Fire at the same Time. Professor *Hollman* seems to have endeavour'd at this and succeeded, by having a tin Tube, in one End of which he put a great many Threads, whose Extremities touch'd the Sphere when in Motion, and

and each Thread collected a Quantity of electrical Fire, the Whole of which center'd in the tin Tube, and went off at the other Extremity. Another Thing to be obſerv'd, is to endeavour to make the Flaſhes follow each other ſo faſt, as that a Second may be viſible before the Firſt is extinguiſh'd. When you tranſmit the electrical Fire along a Sword or other Inſtrument, whoſe Point is ſharp, it often appears as a Number of diſſeminated Sparks, like wet Gunpowder or *Wild-fire*; but if the Inſtrument has no Point, you generally perceive a pure bright Flame, like what is vulgarly call'd the *Blue-ball*, which gives the Appearance of Stars to fired Rockets.

THE following is the Method I made uſe of and was happy enough to ſucceed in. I ſuſpended a Power in ſilk Lines; at the Handle of which I hung ſeveral little Bundles of white Thread,

Thread, the Extremities of which were about a Foot at right Angles from the Poker. Among theſe Threads, which were all attracted by the rubbed Tube, I excited the greateſt electrical Fire I was capable, whilſt an Aſſiſtant near the End of the Poker held in his Hand a Spoon, in which were the warm Spirits. Thus the Thread communicated the Electricity to the Poker, and the Spirit was fired at the other End. It muſt be obſerv'd in this Experiment, that the Spoon with the Spirit muſt not touch the Poker; if it it does, the Electricity without any flaſhing is communicated to the Spoon, and to the Aſſiſtant in whoſe Hand it is held, and ſo is loſt in the Floor.

By theſe Means, I fired ſeveral Times not only the ætherial Liquor or Phlogiſton of *Frobenius* and rectified Spirit of Wine, but even common proof Spirit. Theſe Experiments, as I before obſerv'd, were made laſt *Fri-*

day

day Night, the Air being perfectly dry. *Sunday* proved wet and *Monday* ſomewhat warm, ſo that the Air was full of Vapour; Wind South-Weſt and cloudy. Under theſe Diſadvantages, on *Monday* Night I attempted again my Experiments; they ſucceeded, but with infinitely more Labour than the preceeding, becauſe of the Unfitneſs of the Evening for ſuch Trials. *Your Candour* will not permit you to think my Minuteneſs trivial, with Regard to the Circumſtances of the Weather, who know, how many Things muſt concur to make theſe Experiments ſucceed. I ſhall wait with Impatience for a proper Opportunity to have theſe Experiments repeated in your Preſence, and am, with the utmoſt Reſpect,

Sir, your moſt obedient,

Alderſgate-Street,
March 27. 1746.

humble Servant,

W. WATSON.

TO THE

ROYAL SOCIETY.

GENTLEMEN,

I LATELY acquainted you, that I had been able to fire Spirit of Wine, *Phlogiston* of *Frobenius*, and common proof Spirit, by the Power of Electricity. Since which (till Yesterday) we have had but one very dry fine Day; *viz.* *Monday*, *April* 15. Wind E. N. E; when about four o' Clock in the Afternoon, I got my *Apparatus* ready, and fired the Spirit of Wine four Times from the Poker as before, three Times from the Finger of a Person electrified, standing upon

a Cake of Wax, and once from the Finger of a ſecond Perſon ſtanding upon Wax, communicating with the firſt by means of a walking Cane held between their Arms extended. The horizontal Diſtance in this Caſe between the glaſs Tube and the Spirit was at leaſt ten Feet.

You all know, that there is the repulſive Power of Electricity, as well as the attractive; inaſmuch as you are able, when a Feather or ſuch-like light Subſtance is replete with Electricity, to drive it about a Room, which Way you pleaſe. This repulſive Power continues, until either the Tube loſes its excited Force, or the Feather attracts the Moiſture from the Air, or comes near to ſome non-electric Subſtance; if ſo, the Feather is attracted by, and its Electricity loſt in, whatever Non-Electric it comes near. In electrified Bodies, you ſee a perpetual Endeavour to get rid of their E-

lectricity

lectricity. This induced me to make the following Experiment. I placed a Man upon a Cake of Wax, who held in one of his Hands a Spoon with the warm Spirits, and in the other a Poker with the Thread. I rubbed the Tube amongst the Thread, and electrified him as before. I then ordered a Person not electrified to bring his Finger near the Middle of the Spoon; upon which, the Flash from the Spoon and Spirit was violent enough to fire the Spirit. This Experiment I then repeated three Times. In this Method, the Person by whose Finger the Spirit of Wine is fired, feels the Stroke much more violent, than when the electrical Fire goes from him to the Spoon. This Method for the Sake of Distinction, we will call the repulsive Power of Electricity.

The late Dr. *Desaguliers* has observed in his excellent Dissertation concerning Electricity, "That there is a

" Sort of Capriciousness attending
" these Experiments, or something un-
" accountable in their Phænomena,
" not to be reduced to any Rule.
" For sometimes an Experiment,
" which has been made several Times
" successively, will all at once fail."
Now I imagine that the greatest Part, if not the Whole of this Matter, depends upon the Moisture or Dryness of the Air, a sudden though slight Alteration in which, perhaps not sufficient to be obvious to our Faculties, may be perceived by the very subtle Fire of Electricity. For

1st, I CONCEIVE, that the Air itself (as has been observed by Dr. *Desaguliers*) is an *Electric per se* and of the vitreous Kind; therefore it repels the Electricity arising from the glass Tube, and disposes it to electrify whatever non-electrical Bodies receive the Effluvia from the Tube.

2*dly*, THAT Water is a *non-Electric*, and of Consequence a Conductor of Electricity; this is exemplified by a Jett of Water being attracted by the Tube, *from either Electric*'s *per se* conducting Electricity, and *non Electric*'s more readily when wetted; but what is more to my present Purpose, is, that if you only blow through a dry glass Tube, the Moisture from your Breath will cause that Tube to be a Conductor of Electricity.

THESE being premised; in proportion as the Air is replete with watery Vapours, the Electricity arising from the Tube, instead of being conducted as proposed, is, by means of these Vapours, communicated to the circumambient Atmosphere and dissipated as fast as excited.

THIS Theory has been confirmed to me by divers Experiments, but by none more remarkably than on the E-

vening

vening of the Day I made thofe before-mention'd ; when the Vapours, which in the Afternoon by the Sun's Heat, and a brifk Gale were diffipated, and the Air perfectly dry, defcended again in great Plenty upon the Abfence of both, and the Evening was very damp. For between feven and eight o'Clock, I attempted again the fame Experiments in the fame Manner, without being able to make any of them fucceed ; though all thofe mention'd in this Paper with others of lefs Note, were made in Half an Hour's Time.

I AM the more particular in this, being willing to fave the Labour of thofe, who are defirous of making thefe Kind of Trials ; for although fome of the leffer Experiments may fucceed almoft at any Time, yet I never could find that the more remarkable

able ones would ſucceed but in dry Weather.

I am, Gentlemen,

London, April 25. 1745.

Your moſt obedient,

humble Servant,

W. WATSON.



TO

TO THE

ROYAL SOCIETY.

GENTLEMEN,

IN ſome Papers I lately did myſelf the Honour to lay before you, I acquainted you of ſome Experiments in Electricity; particularly I took notice of having been able to fire Spirit of Wine by what I call'd the repulſive Power thereof; which I have not heard had been thought of by any of thoſe *German* Gentlemen, to whom the World is obliged for many ſurprizing Diſcoveries in this Part of natural Philoſophy.

How

How far ſtrictly ſpeaking the Spirit in this Operation may be ſaid to be fired by the repulſive Power of Electricity, or how far that Power, which repels light Subſtances when fully impregnated with Electricity, fires the Spirit, may probably be the Subject of a future Inquiry; but as I am unwilling to introduce more Terms into any Demonſtration than what are abſolutely neceſſary for the more ready Conception thereof, and as inflammable Subſtances may be fired by Electricity two different Ways, let the following Definitions at preſent ſuffice of each of theſe Methods.

But firſt give me Leave to premiſe, that no inflammable Subſtances will take fire, when brought into or near the Contact of *Electrics per ſe* excited to Electricity. This Effect muſt be produced by non-electrical Subſtances impregnated with Electricity received

ceived from the exciting *Electrics per se*. But to return,

1*st*, I SUPPOSE that inflammable Subſtances are fired by the attractive Power of Electricity, when this Effect ariſes from their being brought near excited non-Electrics.

2*dly*, THAT inflammable Subſtances are fired by the repulſive Power of Electricity; when it happens, that the inflammable Subſtances, being firſt electrified themſelves, are fired by being brought near non-Electrics not excited.

THIS Matter will be better illuſtrated by an Example. Suppoſe that either a Man ſtanding upon a Cake of Wax, or a Sword ſuſpended in ſilk Lines are electrified, and the Spirit, being brought near them, is fired, this is ſaid to be perform'd by the attractive Power of Electricity. But if the Man electrified as before holds a Spoon in his Hand containing the Spirit, or the

the ſame Spoon and Spirit are placed upon the Sword, and a Perſon not electrified applies his Finger near the Spoon, and the Spirit is fired from the Flame ariſing from the Spoon and Spirit upon ſuch Application; this I call being fired by the repulſive Power. Of the two mention'd Kinds I generally find the repulſive Power ſtrongeſt.

SINCE my laſt Communication, the Spirit has been fired both by the attractive and repulſive Power through four Perſons ſtanding upon electrical Cakes; each communicating with the other either by the Means of a walking Cane, a Sword, or any other non-electric Subſtance. It has likewiſe been fired from the Handle of a Sword held in the Hand of a third Perſon.

I HAVE not only fired *Frobenius*'s Phlogiſton, rectified-ſpirit and common proof-ſpirit, but alſo Sal volatile Oleoſum, Spirit of Lavender, dulcified

Spirit of Nitre, Peony Water, *Daffy's* Elixir, *Helvetius's* Stiptic, and ſome other Mixtures where the Spirit has been very conſiderably diluted; likewiſe diſtilled vegetable Oils, ſuch as that of Turpentine, Lemon, Orange Peels and Juniper, and even thoſe of them, which are ſpecifically heavier than Water, as Oil of Saſſafras; alſo reſinous Subſtances, ſuch as Balſam Capivi and Turpentine; all which ſend forth, when warmed, an inflammable Vapour. But expreſſed vegetable Oils, as thoſe of Olives, Linſeed, and Almonds, as well as Tallow, all whoſe Vapours are uninflammable, I have not been able yet to fire; but theſe indeed will not fire on the Application of lighted Paper. Beſides, if theſe laſt would fire with lighted Paper, unleſs their Vapours were inflammable, I can ſcarce conceive they would fire by Electricity; becauſe in firing Spirits, &c. I always perceive that the Elec-

Electricity ſnaps before it comes in Contact with their Surfaces, and therefore only fires their inflammable Vapours.

As an excited non-Electric emits almoſt all its Fire, if once touch'd by a non-Electric not excited, I was deſirous of being ſatisfy'd, whether or no the Fire emitted would not be greater or leſs in proportion to the Volume of the electrified Body. In order to this I procur'd an Iron Bar about five Feet long and near 170 Pounds in Weight; this I electrified lying on Cakes of Wax and Roſin, but obſerved the Flaſhes ariſing therefrom not more violent than thoſe from a common Poker. In making this Experiment, being willing to try the repulſive Force, it once happen'd that whilſt the Bar was at one End electrifying, a Spoon lay upon the other, and upon an Aſſiſtant's pouring ſome warm Spirit into the Spoon, the electrical

trical Flaſh from the Spoon ſnapped and fired the firſt Drop of the Spirit, which unexpectedly fired not only the whole Jett as it was pouring, but kindled likewiſe the whole Quantity in the Pot, in which I uſually have it warm'd.

I FIND, in firing inflammable Subſtances from the Finger of a Man ſtanding upon Wax, that *cæteris paribus* the Succeſs is more conſtant, if the Man inſtead of holding the Thread (the Uſe of which I communicated in a former Paper) in his Hand, the Thread is ſuſpended at the End of an Iron Rod held in one Hand, and he touches the Spirit with one of the Fingers of the other.

IF a Man, ſtanding upon the electrical Cake with a Diſh or deep Plate of Water in one Hand, and the Iron Rod with the Thread in the other, is made electrical; and a Perſon not erectified touches any Part either of the

Plate

Plate or Water, the Flashes of Fire come out plentifully, and wherever you bring your Finger very near, the Water rises up in a little Cone, from the Point of which the Fire is produced, and your Finger, though not in actual Contact, is made wet. The same Experiment succeeds through three or more People.

IN firing inflammable Substances, the Person who holds the Spoon in his Hand to receive the electrical Flashes, when the Finger of the electrified Person is brought near thereto, not only feels a tingling in his Hand, but even a slight Pain up to his Elbow. This is most perceptible in dry Weather, when the Electricity is very powerful.

THERE is a considerable Difficulty in firing *Electrics per se*, such as Turpentine, and Balsam Capivi, by the repulsive Power of Electricity; because in this Case these Substances will not

permit the Electricity to paſs through them; therefore when you would have this Experiment ſucceed, the Finger of the Perſon, who is to fire them, is to be applied as near to the Edge as poſſible of theſe Subſtances when warm'd in a Spoon, that the Flaſhes from the Spoon (for theſe Subſtances will emit none) may ſnap, where they are ſpread the thinneſt, and then fire their Effluvia. This Experiment, as well as ſeveral others, ſerves to confute that Opinion, which has prevail'd with many, that the Electricity floats only upon the Surfaces of Bodies.

If an electrical Cake is dipp'd in Water, it is thereby made a Conductor of Electricity, the Water hanging about it tranſmitting the electrical Effluvia in ſuch a manner, that a Perſon ſtanding thereon can by no means be electrified enough to attract the leaf Gold at the ſmalleſt Diſtance; though the Perſon ſtanding upon the ſame

Cake when dry, attracted a Piece of fine Thread hanging at the Diſtance of two Feet from his Finger. We muſt here obſerve that the Cake being of an unctuous Subſtance, the Water will no where lie uniformly thereon, but adhere in ſeparate Moleculæ; ſo that in this Inſtance the Electricity jumps from one Particle of Water to another, till the Whole is diſſipated.

From the Appearance of the Threads amongſt which I rub the Tube, I can frequently judge, though the Spirit may be many Feet diſtant from them, whether or no it will fire; becauſe when the Perſons ſtanding upon the Wax are made electrical enough to fire the Spirit, the Threads repel each other at their lower Parts, where they are not confin'd, to a conſiderable Diſtance, and this Diſtance is in Proportion as the Threads are made electrical.

If two Perſons ſtand upon electrical Cakes at about a Yard's Diſtance from each other, one of which Perſons, for the Sake of Diſtinction, we will call A, the other B: If A when electrified touches B, A loſes almoſt all his Electricity at that Touch only, which is receiv'd by B and ſtopp'd by the electrical Cake; if A is immediately electrified again to the ſame Degree as before and touches B, the Snapping is leſs upon the Touch; and this Snapping, upon electrifying A, grows leſs and leſs, till B being impregnated with Electricity, though receiv'd at Intervals, the Snapping will no longer be ſenſible.

That Glaſs will repel and not conduct the Electricity of Glaſs, has been mention'd by others, who have treated of this Subject; but the Experiments to determine this Matter muſt be conducted with a great deal of Caution; for unleſs the glaſs Tube, intended to conduct the Electricity, be as warm as the

the external Air, it will ſeem to prove the contrary, unleſs in very dry Places and Seaſons. Thus, I ſometimes have brought a cold, though dry, Glaſs Tube near three Feet long into a Room, where there has been a Number of People; when upon placing the Tube upon Silk Lines, and laying ſome Leaf Silver upon a Card at one End and rubbing another Glaſs Tube at the other, the Silver has, contrary to Expectation, been thrown off as readily as from an Iron Rod. At firſt I was ſurpriz'd at this Appearance, but then conjectur'd, that it muſt ariſe from the Coldneſs of the Glaſs, condenſing the floating Vapour of the Room; in Order then to obviate this, I warm'd the Tube ſufficiently, and this Effect was no longer produced, but the Silver lay perfectly ſtill.

If a Number of Pieces of finely ſpun Glaſs cut to about an Inch in Length, little bits of fine Wire of the ſame Length of what Metal you

pleaſe, and ſmall Cork Balls, are either put all together, or each by themſelves, into a dry pewter Plate, or upon a Piece of poliſh'd Metal, they make in the following Manner a very odd and ſurprizing Appearance. Let a Man, ſtanding upon electrical Cakes, hold this Plate in his Hand with the bits of Glaſs, Wire, &c. detached from each other, as much as conveniently may be; when he is electrified, let him cauſe a Perſon ſtanding upon the Ground to bring another Plate, his Hand, or any other Non-Electric, exactly over the Plate containing theſe Bodies. When his Hand, &c. is about eight Inches over them, let him bring it down gently: As it comes near, in proportion to the Strength of the Electricity, he will obſerve the bits of Glaſs firſt raiſe themſelves upright; and then, if he brings his Hand nearer, dart directly up and ſtick to it without ſnapping. The bits of Wire will

fly

fly up likewiſe, and as they come near the Hand, ſnap aloud; you feel a ſmart Stroke, and ſee the Fire ariſing from them to the Hand at every Stroke; each of theſe, as ſoon as they have diſcharged their Fire, falls down again upon the Plate. The Cork Balls alſo fly up, and ſtrike your Hand, but fall again directly. You have a conſtant Succeſſion of theſe Appearances as long as you continue to electrify the Man, in whoſe Hand the Plate is held; but if you touch any part either of the Man or Plate, the Pieces of Glaſs, which before were upon their Ends, immediately fall down.

Some few Years ago, Sir *James Lowther* brought ſome Bladders fill'd with inflammable Air, collected from his Coal-mines, to the Royal Society. This Air flam'd upon a lighted Candle being brought near it. This Inflammability has occaſion'd many terrible Accidents. Mr. *Maud*, a wor-

thy Member of this Society, made at that Time by Art, and ſhew'd the Society, Air exactly of the ſame Quality. I was deſirous of knowing if this Air would be kindled by electrical Flaſhes. I accordingly made ſuch Air by putting an Ounce of Filings of Iron, an Ounce of Oil of Vitriol and four Ounces of Water into a Florence Flaſk; upon which an Ebullition enſued, and the Air, which aroſe from theſe Materials, not only fill'd three Bladders, but alſo, upon the Application of the Finger of an Electrified Perſon, took Flame and burnt near the Top and out of the Neck of the Flaſk a conſiderable Time. When the Flame is almoſt out, ſhake the Flaſk and the Flame revives. You muſt with your Finger dipped in Water, moiſten the Mouth of the Flask as faſt as it is dried by the Heat within, or the Electricity will not fire it: Becauſe the Flask being an Electric *per*

ſe

ſe will not ſnap at the Application of the Finger, without the Glaſs being firſt made non-electric by wetting. It has ſometimes happen'd, if the Finger has been applied before the inflammable Air has found a ready Exit from the Mouth of the Flask, that the Flaſh has fill'd the Flask, and gone off with an Exploſion equal to the firing of a large Piſtol, and ſometimes indeed it has burſt the Flask. The ſame Effect is produced from the Spirit of Sea Salt, as from Oil of Vitriol; but as the Acid of Sea Salt is much lighter than that of Vitriol, there is no Neceſſity to add the Water in this Experiment.

Those who are not much acquainted with Chemical Philoſophy, may think it very extraordinary, that from a Mixture of cold Subſtances, which both conjunctly and ſeparately are uninflammable, this very inflammable Vapour ſhould be produced. In or-

der

der to ſolve this, it may not be improper to premiſe, that Iron is compounded of a Metallic as well as a ſulphurous Part. This Sulphur is ſo fix'd, that, after heating the Iron red hot, and even melting it ever ſo often, the Sulphur will not be diſengaged therefrom: But upon the Mixture of the Vitriolic Acid, and by the Heat and Ebullition which are almoſt inſtantly produced, the Metallic Part is diſſolved, and the Sulphur, which before was intimately connected therewith, being diſengaged, becomes volatile. This Heat and Ebullition continues 'till the Vitriolic Acid is perfectly ſaturated with the Metallic Part of the Iron, and the Vapour once fired continues to flame, until this Saturation being effected, no more of the Sulphur flies off.

I HAVE heretofore mentioned, how conſiderably perfectly dry Air conduces to the Succeſs of theſe Experi-

ments;

ments; but we have been lately informed by an Extract of a Letter, that *Abbé Nolet* was of Opinion, that they would ſucceed in wet Weather, provided the Tubes were made of Glaſs, tinged blue with Zaffer. I have procured Tubes of this Sort, but, after giving them many candid Trials, I cannot think them equal to their Recommendation. I firſt tried one of them in a ſmart Shower of Rain after a dry Day, when the Drops were large, and the Spirit fired three Times in about four Minutes; the ſame Effect ſucceeded, under the ſame Circumſtances, from the white one; but after three or four Hours raining, when the Air was perfectly wet, I never could make it ſucceed. And to illuſtrate this Matter further, I have been able when the Weather has been very dry, with once rubbing my Hand down this blue Tube, and applying it to the End of an Iron Rod ſix Feet

long, to throw off ſeveral Pieces of Leaf-Silver lying upon a Card at the other End of this Rod, whereas I never have been able to throw it off by any Means in very wet Weather. Beſides, I am of Opinion, that after the Electrical Fire is gone from the Tube, the Tube has no Share in the conducting of it; my Sentiments on that Head I laid before you in a former Paper: For if the Silk Lines are wetted, they diffuſe all the Electricity, and the ſame Effects happen when the Air is wet, be your Glaſs of what Colour it will. It may not be improper here to obſerve, that Zaffer, which is uſed by the Glaſs-makers and Enamellers, is made of Cobalt or Mundick calcin'd after the ſubliming the Flowers. This being reduced to a very fine Powder, and mixt with twice or thrice its own Weight of finely powdered Flints, is moiſten'd with Water and put up in Barrels, in which it

it ſoon runs into a hard Maſs and is call'd Zaffer.

A DRY Sponge hanging by a Pack-thread at the End of an electrified Sword, or from the Hand of an electrified Man, gives no Signs of being made electrical; if it is well ſoak'd in Water, wherever it is touched, you both ſee and feel the electrical Sparks. Not only ſo, but if it is ſo full of Water, that it falls from the Sponge, thoſe Drops in a dark Room, receiv'd upon your Hand, not only flaſh and ſnap, but you perceive a pricking Pain. If you hold your Hand, or any non-electrical Subſtances, very near, the Water which had ceaſed dropping when the Sponge was not electrified, drops again upon its being electrified, and the Drops fall in Proportion to the receiv'd Electricity, as though the Sponge were gently ſqueez'd between your Fingers. I was deſirous to know if I was able to

electrify a Drop of cold Water, dropping from the Sponge, enough to fire the Spirit; but after many unsuccessful Trials, I was forced to desist; because the cold Water dropping from the Sponge not only cool'd the Spirit too much, but also render'd it too weak; likewise, every Drop carried with it great Part of the Electricity from the Sponge. I then consider'd, in what Manner, I could give a Tenacity to the Water, sufficient to make the Drops hang a considerable Time, and this I brought about by making a Mucilage of the Seeds of Fleawort. A wet Sponge then, squeez'd hard and fill'd with this cold Mucilage, was held in the Hand of an electrified Man, when the Drops forced out by the Electricity, assisted by the Tenacity of the Liquor, hung some Inches from the Sponge, and by a Drop of this I fir'd not only the Spirit of Wine, but likewise the inflam-

flammable Air before mentioned, both with and without the Explosion. What an extraordinary Effect is this! That a Drop of cold Water (for the Seeds contribute nothing but add Consistence to the Water) should be the Medium of Fire and Flame.

CAMPHOR is a vegetable Resin, and of Consequence an Electric *per se*. This Substance, notwithstanding its great Inflammability, will not take fire from the Finger of a Man or any other Body electrified, though made very warm and the Vapours arise therefrom in great Abundance. Because, neither Electric's *per se* excited, or electrified Bodies, exert their Force by snapping upon Electric's *per se*, though not excited. If you break Camphor small and warm it in a Spoon, it is not melted by Heat like other Resins; but if that Heat were continued it would all prove volatile. To Camphor thus warm'd, the Finger of an electrified

Man,

Man, a Sword or ſuch-like, will in ſnapping exert its Force upon the Spoon, and the circum-ambient Vapour of the Camphor will be fired thereby, and light up the whole Quantity expoſed. The ſame Experiment ſucceeds by the repulſive Power of Electricity.

A Poker thoroughly ignited put into Spirit of Wine, or into the diſtilled Oil of Vegetables, produces no Flame in either; it indeed occaſions the Vapours to ariſe from the Oil in great Abundance. But if you electrify this heated Poker, the electrical Flaſhes preſently kindle Flame in either. The Experiment is the ſame with Camphor. Theſe Experiments, as well as the following, ſufficiently evince, that the electrical Fire is truly Flame, and that extreamly ſubtil.

I have made ſeveral Trials in order to fire Gunpowder alone, which I

tried

tried both warm and cold, whole and powder'd, but never could make it ſucceed ; and this ariſes in part from its Vapours not being inflammable, and in part from its not being capable of being fir'd by Flame, unleſs the Sulphur in the Compoſition is nearly in the State of Accenſion. This we ſee by putting Gunpowder into a Spoon with rectified Spirit, which, when lighted, will not fire the Powder, 'till by the Heat of the Spoon from the burning Spirit, the Sulphur is almoſt melted. Likewiſe, if you hold Gunpowder ground very fine in a Spoon over a lighted Candle, or any other Flame, as ſoon as the Spoon is hot enough to melt the Sulphur, you ſee a blue Flame, and inſtantly the Powder flaſhes off. The ſame Effects are obſerv'd in the *Pulvis fulminans*, compos'd of Nitre, Sulphur, and fixed Alkaline Salt. Beſides, when the Gunpowder is very dry and ground

very

very fine, it (as you pleaſe to make the Experiment) is either attracted, or repell'd; ſo that in the firſt Caſe, the End of your Finger when electrified, ſhall be cover'd over with the Powder, though held at ſome Diſtance; and in the other, if you electrify the Powder, it will fly off at the Approach of any non-electrified Subſtance, and ſometimes even without it. But I can at Pleaſure fire Gunpowder, and even diſcharge a Muſket, by the Power of Electricity, when the Gunpowder has been ground with a little Camphor or with a few Drops of ſome inflammable chemical Oil. This Oil ſomewhat moiſtens the Powder, and prevents its flying away; the Gunpowder then being warm'd in a Spoon, the electrical Flaſhes fire the inflammable Vapour, which fires the Gunpowder: But the Time between the Vapour firing the Powder is ſo ſhort, that frequently they appear as the ſame and not ſuc-

ceſſive

ceſſive Operations, wherein the Gun-powder itſelf ſeems fired by the Electricity; and indeed the firſt Time this Experiment ſucceeded, the Flaſh was ſo ſudden and unexpected, that the Hand of my Aſſiſtant, who touch'd the Spoon with his Finger, was conſiderably ſcorch'd. So that there ſeems a fourth Ingredient neceſſary to make Gunpowder readily take Fire by Flame, and that ſuch a one, as will heighten the Inflammability of the Sulphur. In common Caſes the lighted Match or the little Portion of red hot Glaſs, which falls among the Powder, and is the Reſult of the Colliſion from the Flint and Steel, fires the Charcoal and Sulphur, and theſe the Nitre. But if to theſe three Ingredients you add a fourth, *viz.* a Vegetable chemical Oil, and gently warm this Mixture, the Oil by the Warmth mixes intimately with the Sulphur, lowers its Conſiſtence, and makes

it readily take fire by Flame. In theſe Operations, notwithſtanding I always made uſe of the fineſt ſcented Oils of Orange Peel, Lemons, and ſuch like, yet upon the leaſt warming the Mixture, the rank Smell of Balſam (*i. e.* the ready Solution) of Sulphur was very obvious.

Read before the R. S.
Oct. 24. 1745.

A Continuation of the Above.

Read, *Feb.* 6. 1745.

AS Water is a non-electric, and of Conſequence a Conductor of Electricity, I had Reaſon to believe that Ice was endowed with the ſame Properties. Upon making the Experiment I found my Conjectures not without Foundation; for upon electrifying a Piece of Ice, wherever the Ice was touched by a non-electric, it flaſhed

flaſhed and ſnapped. A Piece of Ice alſo held in the Hand of an electrified Man, as in the beforementioned Proceſſes, fired warm Spirit, chemical vegetable Oils, Camphor, and Gunpowder prepared as before. But here great Care muſt be taken, that by the Warmth of the Hand, or of the Air in the Room, the Ice does not melt; if ſo, every Drop of Water therefrom conſiderably diminiſhes the received Electricity. In Order to obviate this, I cauſed my Aſſiſtant, while he was electrifying, to be continually wiping the Ice dry upon a Napkin hung to the Buttons of his Coat, and this being electrified as well as the Ice, prevented any Loſs of the Force of the Electricity. The Experiment will ſucceed likewiſe, if, inſtead of the Ice, you electrify the Spirit, *&c.* and bring the Ice not electrified near them. I muſt obſerve, that Ice is not ſo ready a Conductor of Electricity as Water; ſo that I very

frequently have been diſappointed in endeavouring with it to fire inflammable Subſtances, when it has been readily done by a Sword or the Finger of a Man.

In the firſt Paper * I had the Honour to lay before you upon this Subject, I took Notice of my having obſerved two different Appearances of the Fire from electrified Subſtances; *viz.* thoſe large bright Flaſhes, which may be procured from any Part of electrified Bodies, by bringing a Non-Electric unexcited near them, and with which we have fired all the inflammable Subſtances mentioned in the Courſe of theſe Obſervations; and thoſe, like the firing of wet Gunpowder, which are only perceptible at the Points or Edges of excited Non-electrics. Theſe laſt alſo appear different in Colour and Form according to the Subſtances from which they proceed: For from poliſhed Bodies,

* Page 6.

Bodies, as the Point of a Sword, a Silver Probe, the Points of Sciſſors, and the Edges of the Steel-bar made Magnetical by the ingenious Dr. *Knight*, the electrical Fire appears like a Pencil of Rays, agreeing in Colour with the Fire from *Boyle*'s Phoſphorus; but from unpoliſhed Bodies, as the End of a Poker, a ruſty Nail or ſuch-like, the Rays are much more red. The Difference of Colour here, I am of Opinion, is owing rather to the different Reflection of the electrical Fire from the Surface of the Body from which it is emitted, than to any Difference in the Fire itſelf. Theſe Pencils of Rays iſſue ſucceſſively as long as the Bodies, from which they proceed, are exciting; but they are longer and more brilliant, if you bring any Non-Electric not excited near them, though it muſt not be cloſe enough to make them ſnap. If you hold your Hand at about two or three Inches Diſtance

ſtance from theſe Points, you not only feel ſucceſſive Blaſts of Wind from them, but hear alſo a crackling Noiſe. Where there are ſeveral Points, you obſerve at the ſame Time ſeveral Pencils of Rays.

It appears from Experiments, that beſides the ſeveral Properties, that Electricity is poſſeſs'd of peculiar to itſelf, it has ſome in common with Magnetiſm and Light.

PROPOSITION I.

In common with Magnetiſm, Electricity counteracts, and in light Subſtances overcomes the Force of Gravity. Like that extraordinary Power likewiſe, it exerts its Force *in Vacuo* as powerfully as in open Air, and this Force is extended to a conſiderable Diſtance through various Subſtances of different Textures and Denſities.

COROLLARY.

GRAVITY is the general Endeavour and Tendency of Bodies towards the Center of the Earth; this is overcome by the Magnet with Regard to Iron, and by Electricity with Regard to light Subſtances both in its Attraction and Repulſion; but I have never been able to diſcern that vortical Motion, by which this Effect was ſaid to be brought about by the late Dr. *Deſaguliers* and others, having no other Conception of its Manner of acting than as Rays from a Center, which indeed is confirmed by ſeveral Experiments. One of which, very eaſy to be tried, is, that if a ſingle downy Seed of Cotton Graſs is dropped from a Man's Hand, and in its Fall comes within the Attraction of the rubbed Tube; the Down of this Seed, which before ſeemed to ſtick together, ſeparates, and forms

forms Rays round the Center of the Seed: Or if you faſten many of theſe Seeds with Mucilage of Gum Arabic, round a Bit of Stick, the Down of them when electrified, which otherwiſe hangs from the Stick, is raiſed up, and forms a circular Appearance round the Stick. As theſe light Bodies are directed in their Motions, only by the Force impreſſed upon them, and as their Appearance is conſtantly *radiatim*, ſuch Appearance by no Means ſquares with our Idea of a Vortex. Some have imagined a Polarity alſo, when they have obſerved one end of an excited Glaſs Tube repel light Subſtances, and the other attract them. But this Deception, ariſing from the whole Length of the Tube not being excited, but only ſuch Part of it as has been rubbed; ſo that as much of the Tube as is held in the Hand, remains in an unexcited State, and permits light Subſtances to lie ſtill thereon, though forcibly repell'd at

the

the other End. This attractive Power of Electricity acts not only upon Non-electrics, as Leaf-Gold, Silver, Thread, and ſuch like, but alſo upon originally Electrics, as Silk, dry Feathers, little Pieces of Glaſs and Reſin; it attracts all Bodies, that are not of the ſame Standard of Electricity, (if I may be allowed the Expreſſion) as the excited Body from which it proceeds. I have found no Body however denſe, whoſe Pores are not pervious to Electricity by a proper Management, not even Gold it.

PROPOSITION II.

IN common with Light, Electricity pervades Glaſs, but ſuffers no Refraction therefrom; I having from the moſt exact Obſervations found its Direction to be in right Lines, and that through Glaſſes of different Forms,

included one within the other, and large Spaces left between each Glaſs.

Corollary.

This rectilineal Direction is obſervable only as far as the Electricity can penetrate through unexcited Originally-electrics, and thoſe perfectly dry; nor is it at all material, whether theſe Subſtances are tranſparent, as Glaſs; ſemidiaphanous, as Porcelain or thin Cakes of white Wax; or quite opake, as thick woollen Cloth, as well as woven Silk of various Colours; it is only neceſſary that they be Originally-electrics. But the Caſe is widely different with Regard to Non-electrics; wherein the Direction, given to the Electricity by the excited originally-electric, is alter'd as ſoon as it touches the Surface of a Non-electric, and is propagated with a Degree of Swiftneſs ſcarcely to be meaſured in all poſſible

ſible Directions to impregnate the whole Non-electric Maſs in Contact with it, or nearly ſo, however different in itſelf, and which muſt of Neceſſity be terminated by an originally Electric, before the Electricity exerts the leaſt Attraction, and then this Power is obſerved firſt at that Part of the Non-electric the moſt remote from the originally-electric. Thus for Example, by an excited Tube held over it, Leaf Gold will be attracted through Glaſs, Cloth, &c. held horizontally in the Hand of a Man ſtanding upon the Floor, and this Attraction is exerted to a conſiderable Diſtance. On the contrary, the rubbed Tube will not attract Leaf Gold or other light Bodies, however near, through Silver, Tin, the thinneſt Board, Paper, or any other Non-electric, held in the Manner before-mentioned. But if you rub the Paper over with Wax

 melted,

melted, and by that Means introduce the originally-electric therein, you observe the Electricity acts in right Lines, and attracts powerfully. And here I must beg Leave to remind you, not only of the former Corollary, but of some of the former Experiments also; by which it appears, that although, to make a Non-electric exert any Power, we must excite the whole Mass thereof, yet we can excite what Part, and what only, of an originally-electric we please. Thus we observe, that Leaf-gold, and the Seed of Cotton-grass, (which grows upon Boggs and is a very proper Subject for these Inquiries) are attracted under a Glass Jar made warm *, and turned Bottom

* I have constantly observed, that the electrical Attraction through Glass is much more powerful, when the Glass is made warm, than when cold. This Effect may proceed from a two-fold Cause: First, warm Glass does not condense the Water from the Air, which makes the Glass, as has been before

tom upwards, upon which are placed Books and ſeveral other Non-electrics; and that the Motions of the light Bodies underneath correſpond with the Motions of the Glaſs Tube held over them, the Electricity ſeeming inſtantaneouſly to paſs through the Books and the Glaſs. But this does not happen, till the Electricity has fully impregnated the Non-electrics, which lie upon the Glaſs, which received Electricity is ſtopped by the Glaſs, and then theſe Non-electrics dart their Power directly through the upper Part of the Glaſs after the Manner of Originally-electrics. But if the thinneſt Non-electric, even the fineſt Paper, as I before mentioned, is held in the Hand

before † demonſtrated, a Conductor of Electricity: ſecondly; As heat enlarges the Dimenſions of all known Bodies, and conſequently cauſes their conſtituent Parts to recede from each other, the electrical Effluvia, paſſing in ſtraight Lines, find probably a more ready Paſſage through their Pores.

† Page 13.

Hand of a Man at the ſmalleſt Diſtance over the Leaf-Gold, and the Electricity is not ſtopped, not the leaſt Power will be exerted, and the Gold will lie ſtill. I muſt here remark likewiſe, that this Law of Electricity is ſo conſtant and regular, that I have not found one Deviation from it; ſo that even the Quickſilver, ſpread thin as it uſually is at the Back of a Plate of a Looking-glaſs, will prevent the paſſing through of the electrical Attraction, unleſs ſtopped by an Originally-electric. This Penetration of the electrical Power through originally-electrics is much greater than has hitherto been imagined, and has cauſed the Want of Succeſs to great Numbers of Experiments. I have been at no ſmall Pains to determine, how far this Power can penetrate through a dry Originally-electric; and have found by repeated Trials, that either in a Cake of Wax alone, or of Wax and

Reſin

Resin mixed, when the Electricity is very powerful, it has passed, I say, in straight Lines through these Cakes of the Thickness of 2 Inches and $\frac{4}{10}$; but I never could make it act through one of 2 Inches $\frac{8}{10}$, for in this it was perfectly stopped. So that the Cakes commonly made use of to stop the Electricity, by being too thin, suffer a considerable Quantity of the electrical Power to pervade them, and be lost in the Floor. I make no Doubt, if the electrical Power could be more increased, it would penetrate much further through these Originally-electric Bodies.

Proposition III.

Electricity, in common with Light likewise, when its Forces are collected and a proper Direction given thereto upon a proper Object, produces Fire and Flame.

COROLLARY.

THE Fire of Electricity (as I have before obſerved) is extremely delicate, and ſets on Fire, as far as I have yet experienced, only inflammable Vapours. Nor is this Flame at all heightned by being ſuperinduced upon an Iron Rod, red hot with coarſer culinary Fire, as in a preceeding Experiment; nor diminiſhed by being directed upon cold Water. However I was deſirous of knowing, if this Flame would be effected by a ſtill greater Degree of Cold; and in order to determine this, I made an artificial Cold; by which the Mercury, in a very nice Thermometer adjuſted to *Fahrenheit's* Scale, was depreſſed in about 4 Minutes from 15 Degrees above the freezing Point to 30 Degrees below it, that is, the Mercury fell 45 Degrees. From this cold Mixture, when electrified, the Flaſhes were as powerful and the

the Stroke as ſmart as from the red hot Iron. I could have made the Cold more intenſe, but the above was ſufficient for my Purpoſe. This Experiment ſeems to indicate, that the Fire of Electricity is affected neither by the Preſence or Abſence of other Fire. For as red hot Iron, by Sir *Iſaac Newton*'s Scale of Heat, is fixed at 192 Degrees, and as the Ratio between Sir *Iſaac*'s Degrees and *Fahrenheit*'s is as 34 to 180, it neceſſarily follows, that the Difference of Heat between the hot Iron and the cold Mixture is 1040 Degrees; and nevertheleſs this vaſt Difference makes no Alteration in the Appearance of the electrical Flame. We find likewiſe, that as the Fire, ariſing from the Refraction of the Rays of Light by a *Lens*, and brought to a *Focus*, is obſerved firſt at ſome ſmall Diſtance from their Surfaces, to ſet on Fire combuſtible Subſtances; the ſame Effect, as I have

before obſerv'd, is produced in like Manner by electrical Flame.

I MAY perhaps be thought too minute in ſome of the before-mentioned Particulars; but in Inquiries abſtruſe as theſe are, where we have ſo little *a priori* to direct us, the greateſt Attention muſt be had to every Circumſtance, if we are truly deſirous of inveſtigating the Laws of this ſurprizing Power. For, as has been ſaid upon another Occaſion by my ever honoured Friend MARTIN FOLKES, Eſq; our moſt worthy Preſident, " that Electricity ſeems to furniſh an inexhauſtible Fund for Inquiry; and ſure " Phænomena ſo various and ſo wonderful can ariſe only from Cauſes very general and extenſive, and ſuch as " muſt have been deſigned by the Almighty Author of Nature for the " Production of very great Effects, and " ſuch as are of great Moment to the " Syſtem of the Univerſe."

IF

If these Obſervations receive the Countenance of this learned Society, I ſhall think myſelf ſufficiently recompenſed, and am,

Gentlemen, with the higheſt Eſteem,

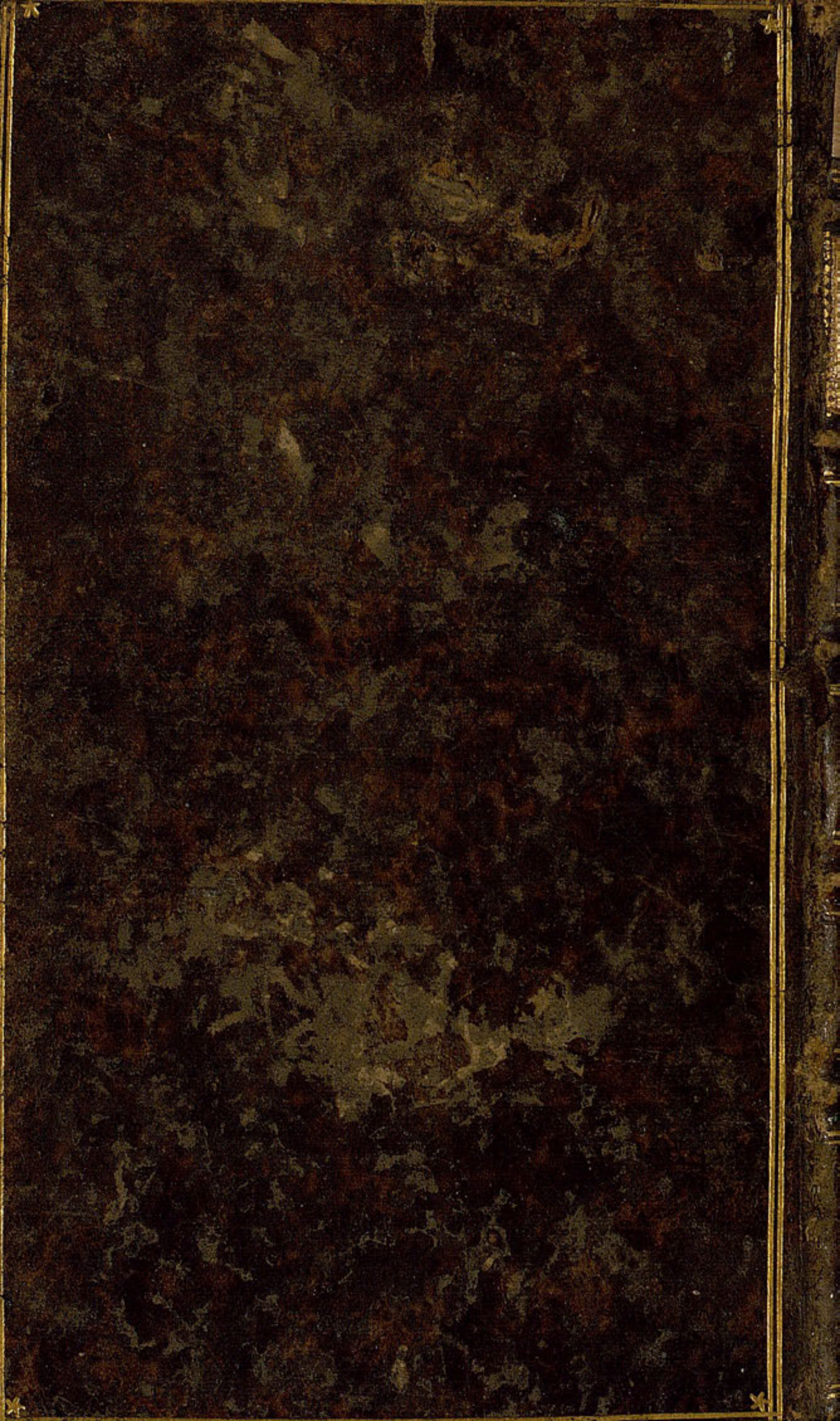
your moſt Obedient

humble Servant,

W. Watson.

F I N I S.







EXPERIM
OF
ELECTRIC







